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A Southern California Gas Company Project Sage Report

Selected U.S. Building Industry Processes and Characteristics

Prepared for
Southern California Gas Company
by

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

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January 1978

Prepared for
Southern California Gas Company
by
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

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NOTICE

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PREFACE

Project SAGE has as its goal to define the equipment design, cost requirements, government policies and initiatives, market requirements, and institutional changes for successful commercial application of solar-assisted gas energy (SAGE) water heating.

The project is being conducted by the Southern California Gas Company in several phases, using the skills of the Environmental Quality Laboratory (EQL) and Jet Propulsion Laboratory (JPL) of the California Institute of Technology; industry; and consultants from the School of Architecture and Urban Planning and the Institute of Government and Public Affairs of the University of California, Los Angeles (UCLA).

Project SAGE is defined by a multidisciplinary team focusing on the broad problem of introducing solar energy into the U.S. building industry on a scale which could have a significant impact on the demand for fossil fuels. The regional character of the building industry leads to focusing the effort on Southern California. For the residential sector and for Southern California, water heating is a significant consumer of energy — 27% of residential energy, or 6% of primary energy. Water heating in apartments is the most likely application of solar energy to become economically competitive in the near term. In addition, a mutually beneficial relationship between solar water heating and the gas utility industry has been conceived.

In Phase I of Project SAGE,[1] the technical and economic feasibility of solar-assisted gas energy water heating was investigated for apartments. A point design approach was used to determine equipment and installation costs and a computer simulation model was used to estimate the performance of the system using hourly historical weather data. For a system minimizing the cost of solar energy, it was found that SAGE water heating systems have the potential to reduce the capacity required for systems to deliver natural or synthetic gas to a utility company.

The conclusions of Phase I are based on detailed cost and performance analyses of a single baseline system. Other systems are also identified in Phase I. In Phase II, the performance of the baseline systems and several alternate systems are evaluated, using experimental data from a pilot plant.[2] (The pilot plant is scaled to a 10-unit apartment.) Costs are estimated for alternate systems sized to give equal performance. A system is selected for further development and

[1] Davis, E.S., Project SAGE Phase I Report, EQL Memorandum No. 11, California Institute of Technology, Pasadena, Ca., June 1973.

[2] Bartera, R.E., and Davis, E.S., Project SAGE Phase II Report, Design and Evaluation of Solar-Assisted Gas Energy Water Heating Systems for New Apartments, Report 5030-15, Jet Propulsion Laboratory, Pasadena, Ca., January 1976.

field testing. Finally, the designs for the system and components are established for a SAGE system which meets the life performance and cost requirements of the U.S. apartment application.

In Phase III, the equipment is being tested in the field, and the marketing and institutional problems that challenge rapid and widespread use of SAGE water heating are being addressed.

This report is part of the Architectural Analysis subcontract and is a primarily graphic characterization of the U.S. building industry. The purpose of this work is to provide the contextual framework within which a SAGE water heating installation, as a building system component, will have to be analyzed to optimize its interface with conventional building systems.

ACKNOWLEDGEMENT

Special thanks and acknowledgement are given to Kuppaswami Iyengar, Bruce Robinson and Richard H. Benson, graduate students at the UCLA School of Architecture and Urban Planning, for their assistance in this project, particularly in the graphic presentations.

For further information regarding this work, contact R. E. Bartera at the Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, California, 91103.

ABSTRACT

Selected multifamily processes are examined (using a primarily graphic approach) to clarify some of the operational modes into which Project SAGE (solar-assisted gas energy) must fit, both as a product and a process in the U.S. building industry.

What SAGE must have or "do" in order to fit the building industry in the short term (that is, the multifamily submarket as it is presently configured) is delineated in the report.

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SECTION I

INTRODUCTION

In the aggregate, construction is one of the largest industries in the U.S. economy. It is a multifaceted process delivering a complex product to every part of this country and the world. It can be characterized in a wide variety of ways. A complete description is beyond the interest of the Project and the scope of this report. Specifically, the industry is of interest here as the vehicle for, and target of, SAGE system commercialization. This shall be the primary filter for the following discussion.

For example, one means of delineating the industry is by building type, or primary submarkets around which it is largely organized. Few building-type lists entirely coincide with each other, but the American Institute of Architects list in Figure 1-1 provides perhaps the most appropriate degree of differentiation. As SAGE is intended for use in "Low-Rise Multiple Residential" buildings, this report is largely restricted to Category 3 of that list.

A. REPORT OBJECTIVES

Solar energy has yet to be applied in significant numbers within the housing submarket. Much of the Project's interest in the industry has therefore been in terms of its acceptance of, or resistance to, innovative technology. These issues have been the subject of numerous investigations by various Project team members (A. Hirshberg, R. Schoen) and elsewhere in terms of communication of innovations (Reference 1-1) — although less in the building industry than in others.

Acceptance of technical innovation will not be a direct concern of this report. Rather, selected multifamily processes will be examined (using primarily a graphic approach) in order to make clear some of the operational modes into which SAGE must fit—both as product and process. In a related series of reports, two actual SAGE installation experiences are being summarized. Comparison of demonstration project results with the kinds of industry characteristics reported here have lead to the creation of "utilization requirements" for SAGE. These indicate what SAGE must have — or "do"in order to fit the building industry <u>in the short term</u> — that is, the multifamily submarket as it is presently configured.

B. REPORT ORGANIZATION

For simplicity, the multifamily submarket will be herein termed the "housing industry". Many people involved in construction actually consider it a separate industry, apart from the rest of U.S. construction. Housing is people centered: it requires countless decisions by a large and varied group of individuals for conception to become

1 Residential, Single Family
2 Residential, Multiple High Rise
3 Residential, Multiple Low Rise
4 Hotel/Motel, High Rise
5 Hotel/Motel, Low Rise
6 Office Building, High Rise
7 Office Building, Low Rise
8 Warehouse
9 Industrial, Light Process Load
10 Industrial, Heavy Process Load
11 Single Story Educational
12 College/University
13 Auditoriums
14 Health Care, Clinic
15 Hospital
16 Retail, Merchandise Mall
17 Retail, Individual Store
18 Mobile Homes

Figure 1-1. Building Types Prevalent in the U.S. Construction Industry
Source: The American Institute of Architects

reality—for raw materials to finally be transformed into living spaces. This fact is basic to attitudes toward risk, innovation, and resultant change within the industry.

For these reasons, the housing industry is discussed here in terms of the decision-making environment extant in the multifamily development process; the actors involved in that process, the roles they play, and the timing and duration of those roles. The multiple-decision making process is further personified via a discussion of the building code and community zoning processes to which all housing development is subjected...and which impacts various of those actors in different ways. Finally, some initial endeavor is made to fit Solar Assisted Gas Energy for multifamily domestic hot water heating into those processes.

SECTION II

THE MULTIFAMILY DEVELOPMENT PROCESS

A. OVERVIEW

Consistent with the limited objectives of this report, housing will be discussed exclusively in micro- rather than macro-economic terms. That is, individual housing transactions and the decision-making processes relating to them. Individual pieces of property and investment opportunities are of importance here, rather than the aggregate size of housing production in relation to the Gross National Product, or whether the resulting share is optimal in terms of policy at each level of government, etc.

Smith (Reference 2-1) has described housing as a large bundle of (economic) resources. He saw the principal types of resources within that bundle, or "inputs to the housing sector" as finance, land, building materials, labor force, builder's equipment, and entrepreneurship. Figure 2-1 summarizes these and other resources. It also shows-and emphasizes-the actors, institutions, and instruments required to provide them. Although the title might imply an orderly "process" this particular figure suggests the complexity of input elements, incredible number of individuals and institutions involved and, thereby, the diversity in decisions which are regularly made. That complexity is not surprising, in view of the nature of the finished product. It has been estimated that the single family house is made up of more than 35,000 separate parts. It can be assumed that multifamily structures are made up of multiples of perhaps a slightly smaller number of individual component elements. Those elements must be assembled from all parts of the nation in one place according to a predetermined set of perceptions and objectives.

Despite apparent outward similarities, the resulting product is quite heterogeneous in nature. It must be produced for all types of unique building sites and in an incredible range of community types and climatic regions. Viewed in this light, the production of housing would seem to demand a not insignificant combination of market sensitivity and managerial/organizational talent. This suggests that entrepreneurship is almost more "important" than the other inputs because it is the entrepreneur who must organize, become at least partially responsible for, and eventually commit those resources.

The importance of the entrepreneur is underscored by the fact that it is the popular presumption (correct or otherwise) "that demand, not supply factors, limit housing in the United States". The volume of house building is assumed to be limited primarily by the number of buyers or renters. "It does not usually occur to housing economists in the United States to wonder if there are enough carpenters or bankers or

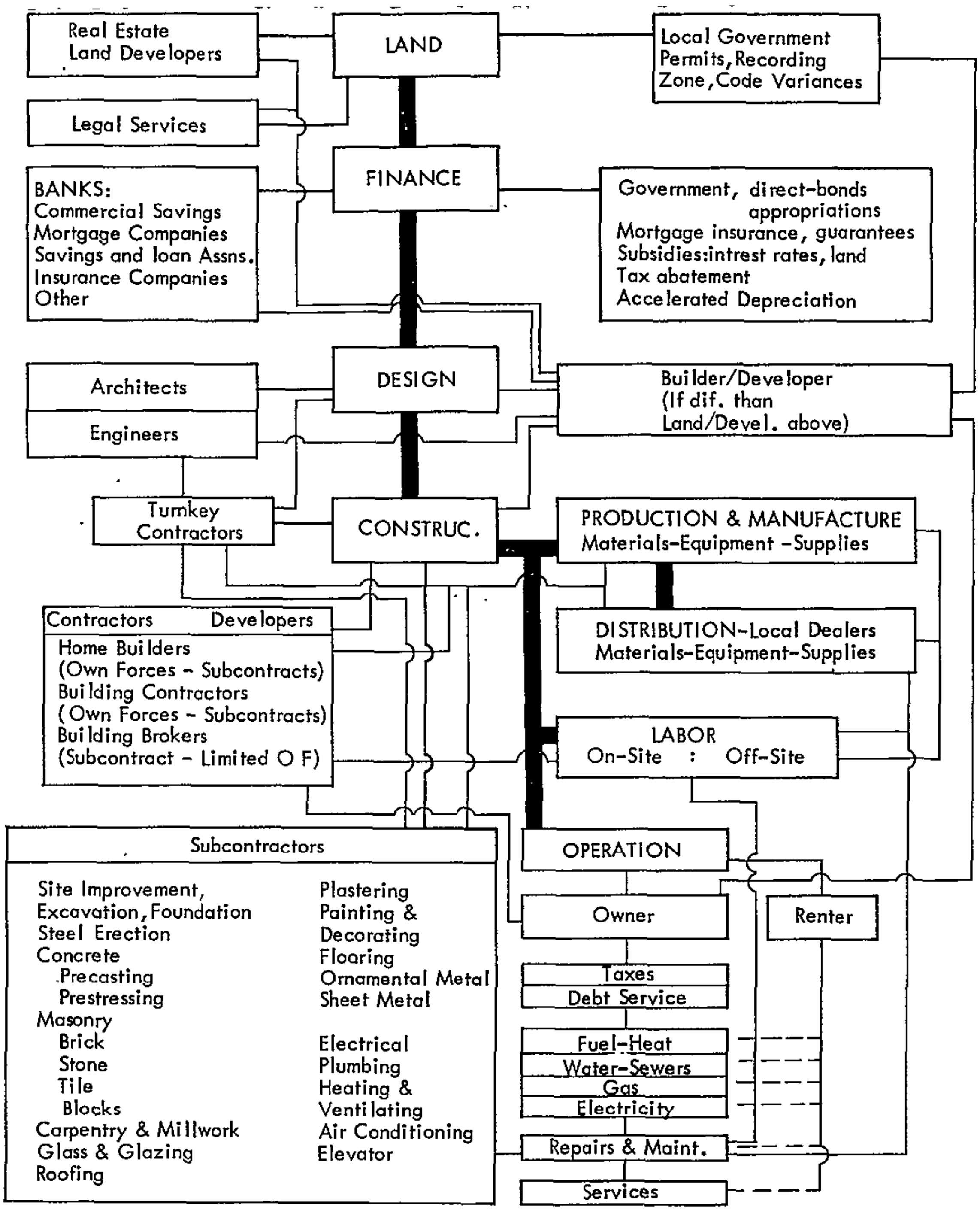


Figure 2-1. Low Rise Multifamily Development Process Flow

entrepreneurs to respond to an increase in effective demand." (Reference 2-1 p. 117). (The one recent situation where concern was expressed about availability of enough skilled laborers to participate in a doubling of housing output to meet the 10-year goals of the 1968 U.S. Housing Act — without a 30% increase in their wages — proved to be unfounded. Once interest rates were eased, by late 1969, the industry met, at least for the next few years, the 10-year production goal, on an annualized basis, without a significant scarcity in skilled labor or a resultant quantum increase in wage demands.) However, with the medium price of the U.S. single family house now $50,000, "supply" — of affordable housing — may become the limiting factor.

At this time, however, creation of market demand is seen as necessary in order for the nation to be able to absorb all that the industry can produce. This is quite unlike conditions in underdeveloped as well as many developed nations of Europe and the Far East. There, demand is perceived as virtually infinite. This is true not because the population is "unlimited" but because the situation in which an adequate amount of housing has been produced is unthinkable or at least quite remote. Thus, there is no give and take of a "housing market" in the U.S. sense of the term. An increase in resources available to the housing sector in a given planning period is equated with a direct increase in the volume of housing which will be produced (Reference 2-2).

In spite of this essential organizing function played by the entrepreneur, Smith notes that the entrepreneural input is most often overlooked. He is frequently confused with the investor, but his investment activities may be minor. The same is true of his building role, although he may or may not operate a building business.

> "the entrepreneur is the person (or firm) who perceives or thinks he perceives a market demand for (a particular kind of) new housing and organizes all the resources necessary to meet that demand. He is, in essence, a middle man — one who buys components, assembles a product, and sells that product at a profit, which represents his wage (Reference 2-2).

While not completely necessary to the production of a single family home, his role is crucial to multifamily housing.

Finally, a local housing market is inherently dynamic — it is constantly responding to changes in elements of supply and demand. The mechanics of housing are highly interdependent. However, individual participants in housing engage in business to achieve individual goals, not to achieve some community objective, fulfill a social requirement (such as conserving energy) or respond faithfully to public acts and programs necessarily in terms conceived by their framers (Reference 2-1) For all of the preceeding reasons, this overview of the multifamily development process can be seen most effectively through an examination of the organizing, entrepenuerial role of the individual housing developer. This approach will in turn allow for subsequent condensed thumbnail sketches of related key housing actors and their roles within that overall process.

It should be noted in passing that the entrepeneurial role can be public as well as private - community housing authorities are also "developers." But the public role in housing should not be construed merely in the simplistic terms of "subsidized housing versus market rate commercially produced housing." As Smith has observed, there is a dual nature to housing, a "blend of private enterprise and government activity (Reference 2-1, p. 10). Even this description tends to suggest to champions of private enterprise that any form of government involvement is "meddling" and that the private sector can and should "go it alone." In fact, the housing industry is entirely dependent upon the existance of a set of laws, institutions, and public agencies for its ability to operate efficiently—if not to exist entirely. These are beyond the ability of the individual developer to create or maintain as they are crucial to his ability to operate. For example, there must be community recognition of, and legally established precedent for, the concept of real property ownership. Builders will not build, financiers lend, nor buyers commit funds for dwellings without community assurances for respect of property rights to the resulting product. Financing a product so heterogeneous and long-lived would also be impossible without some established and regulated form of financial midwifery. This is the case in all developed countries.

The quality of housing as a delivered service also depends heavily upon the transportation system, schools, utilities and other public facilities, as well as upon the manner in which nearby land uses are controlled. These attributes are known as the community infrastructure. They were provided for by the taxpayer rather than the developer, since development used to be considered a prima facia good for any community in terms of the new jobs and expanded tax role it was purported to bring. It is only recently that these assumptions have been questioned and the developer subsequently required to pay his "fair share" of such services. Communities are now increasingly regulating their own rate of growth.

In fact, it is this public regulatory function which has become the bane of the developer...and the tool of the environmentalists in their growing battle over the use of <u>all</u> community resources, including land itself. It is also this function which has become the focal point for the regulation of energy use in buildings and the promotion of alternative, renewable energy sources for that purpose.

B. VIEW FROM THE ENTREPRENEUR'S ROLE

Development is the process by which (primarily urban) land is modified to accomodate a "best" use in the form of a structure or some other capital improvement. The "best" use depends upon who is making the decision. This could be the land owner or perhaps the ultimate occupant of that structure. Generally, however, the ultimate user is remote from the immediate development decision. He is more usually an ordinary consumer in the market place, reacting favorably or unfavorably to what is available for his use, when he needs it. That is, the development process is long, costly, and requires special expertise. It is difficult for most consumers to perceive such needs sufficiently in advance and to have the capability of responding to them.) Ownership or at least control of the land can also be acquired with relatively little capital, thereby removing the development decision from the exclusive purview of the land owner as well.

The development process therefore falls to the province of the entrepreneur and his special brand of skills and risk-taking abilities. These include: his knowledge of the "market"; skill in business and legal matters related to the production of housing; knowledge of housing technology and design in the broadest sense; and a willingness to bear the risk that his efforts may yield less than expected. In addition, he may supply some circulation capital, although he primarily works on money provided by others—paying well for the opportunity to use that money and to leverage his own modest investment while reducing personal risk in the process. In producing housing as a commodity for sale, he formulates a plan, assembles resources, makes the transformation of those resources into housing, and sells the product. For this effort the developer expects a reasonable "output" from the project — a return on both his investment and his efforts. Most forms of return or gain can be translated into the difference between the value of the completed property and the sum of all land and development costs. (It's actual maximum selling price may little relate to either.) The means by which this translation is accomplished, the rate and time of return expected for entrepreneurial knowledge and risk-taking, and the cost of managing the project during his limited ownership of it, combine to make the developer a speculator, long term investor, or public authority. All housing is not speculative, but all housing production must involve entreprenurial decision-making. Figure 2-1 represents one view of the entreprenuerial decision-making process. However idealized, it does suggest the flow of information, the type of decisions required, and selected possible outputs in several basic areas confronting the developer (from Smith, Reference 2-1).

There is actually no finite starting point for the process. The active developer is constantly analyzing the various segments of users (process A). He does this by continuously familiarizing himself with housing demand and the stock and flow of housing within the community in which he intends to operate. (Often it was on this single requirement alone - "knowing the territory" - that so many attempts at nationally-scaled housing production foundered.) In particular, the developer must know—or better yet, be able to predict in advance any significant changes in those and other key attributes of that community.

In this way he can project demand and know what kind of housing will be required and what its requirements must be to make it competitive.

However, the ultimate user often is not the long term investor or holder of the property (e.g. in rental housing). The developer must therefore understand investor response to these factors. That is, he must analyze the "purchaser market" (process B). The output of these two steps result in a more refined, perhaps narrower set of market options than merely knowing community housing needs alone.

The process of refinement continues through "analysis of market segments" (process C) within the overall demand patterns described above—in order to produce an array of actual alternatives to which the developer might respond. To be able to subsequently make that choice he must now determine what each alternative will need as input requirements and judge them against his own abilities and objectives. (These two characterizing elements - needs and abilities/objectives - combine to become the primary reason why different actual individuals and organizations may be operating within each residential-type submarket in the Figure 1-1 (AIA) Building Type list preceding, even though they might all show up on process charts wearing the same generic "hat" as developer.)

Project inputs will include the complete bill of materials, services, and business procedures and acumen required to produce and sell each form of housing, as suggested in Figure 2-2 "inputs" to process C. As a result, the amount of required developer input can be measured against expected output to (earnings for) the developer for each alternative. The decision is both simplified and constrained if the developer already owns or holds an option on a parcel of land within his target community.

However, the acquisition and holding of undeveloped land is an expensive process, in spite of its appreciation rate in most urban areas in recent years. (More precisely, it may show continuous appreciation in suburban areas but may actually suffer decreases in value in the urban core of many U.S. cities.) Recalling the essentially middleman function of the developer, site acquisition is usually preceded by opportunity assessment in the chosen geographical area. Subsequently, ideal or even appropriate sites may not be found available for the chosen alternative housing type. Reanalysis therefore often takes place in determining the best use for an actual, available parcel under process D.

Having acquired at least an option on, if not title to the land, the developer's "clock is now running." Every day of delay adds to his already considerable carrying costs for the land—under either form of control. Detailed development plans must be made rapidly for the parcel or parcels of land now tied up, in order to transition from process D, "Site Use Determination," to process E "Actual Project Selection" for a given site or sites (or none at all if that is determined). At this point, the developer hires a wide variety of professional consultants to help him in making his determination. (Larger

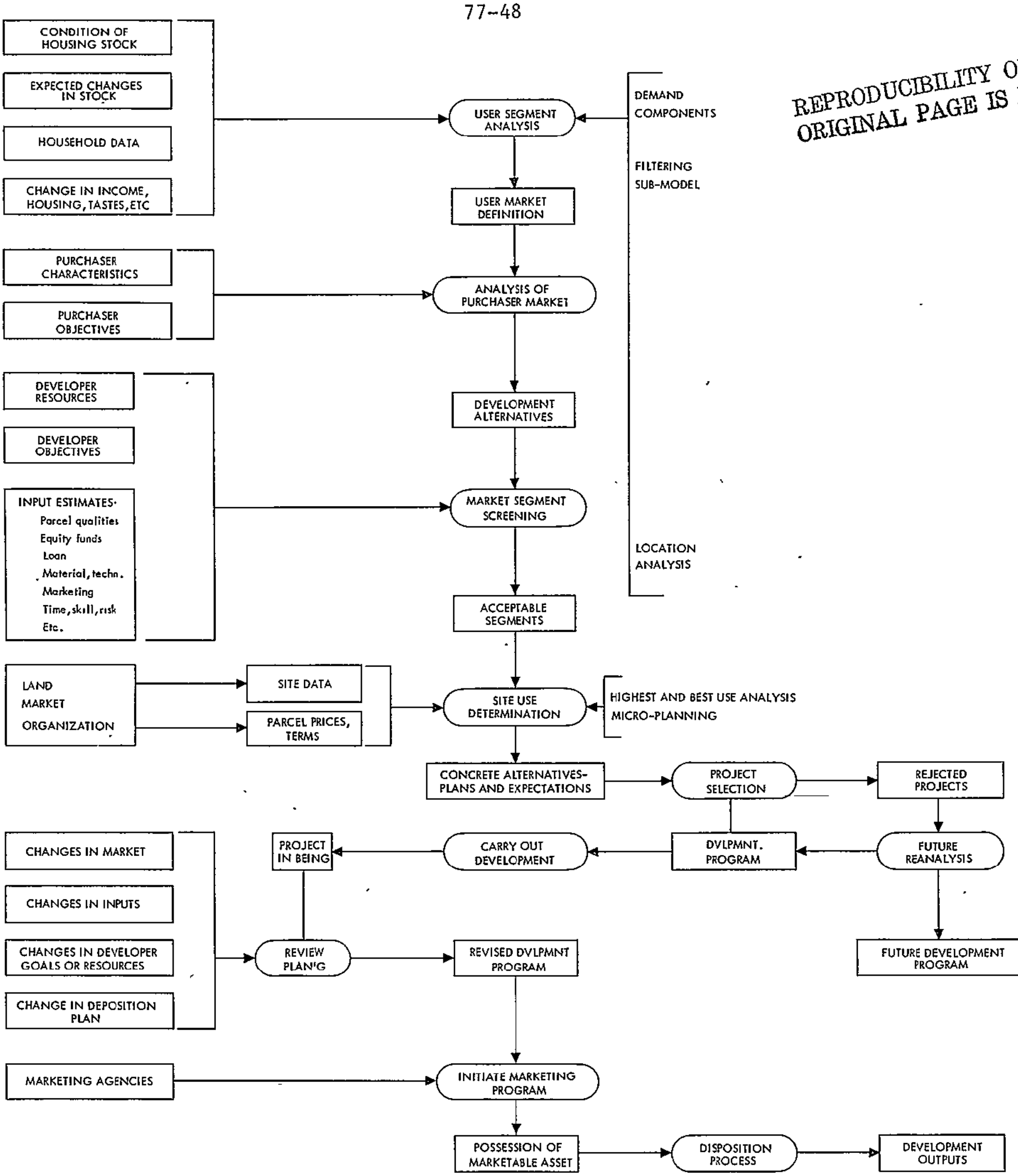


Figure 2-2. Housing Developer Decision System

Source: Smith, Wallace F., "Housing the Social and Economic Elements," University of California Press, Berkeley, Calif., 1970.

organizations may have these skills "in-house" but the high cost of their continued "maintenance" plus the wider choice available in the competitive marketplace has discouraged expansion of that practice.) His consulting professionals include architects, engineers, landscape architects, perhaps specialized marketing experts, interior designers, and even geologists and environmentalists for certain types of projects in certain areas. They are charged with creating and designing the final form of that development project in cooperation with the developer. They also assist him in determining relative feasibility of the alternative approaches they produce for use of the chosen site. They are charged to do so with maximum speed.

The chosen development is actually "carried out" or constructed under process G. At this point, it may be put into the hands of one or more contractors working for the developer or he may himself play the role of builder or contractor and become directly responsible for all or part of the physical process of site preparation and building construction. More frequently, the reverse is true. It is established building contractors who subsequently become developers. However, other established individuals in the housing industry—architects, appraisers, engineers, managers, financiers, etc., may also feel they have discovered and understand an opportunity to put together a product that would sell for a price exceeding its combined costs—e.g., they have perceived what they feel to be an unmet market demand and have the credibility to persuade backers to go along in order to get the project going.

Note that process F was not discussed. In reality, it is the application of all the preceding steps, to projects discarded after initial analysis in favor of more promising alternatives during the immediate time frame. No developer ever really totally gives up a project once he has invested even a modest amount of resources in its investigation. He simply keeps it "on the back burner" until (if and when) the time comes that conditions have changed either in his mode operation and portfolio or in characteristics surrounding the alternative which might then combine to make it more interesting at a later date. In fact, as antidevelopment forces have learned, often the hard way, this is true whether a freeway project or a housing development was the "rejected alternative."

The construction process is far from instantaneous. It takes a certain amount of time, during which the developer slowly becomes proprietor of a project in being. During that time, various irrevocable commitments are made—but the decision-making environment and the project's prospects may have both altered during the process. Within the constraints of an increasingly "fixed" project, circumstances may arise calling for change in construction, design, or disposition of the project upon, or even during its completion. Thus, process H calls for continuous updating of the development program, and revisions during the physical portion of the development process may be numerous.

The marketing process may (process I) commence upon Project completion. However, in multifamily development, it is more than likely

that a serious marketing program is begun during construction and is itself susceptible to refinement and change during that phase, as noted above.

The final step, process J, involves "Disposition of the Project" in order to achieve the outputs or benefits to the developer originally envisioned upon initiation. It is not the <u>concluding</u> step in the development process. What really is involved is a cyclical endeavor with each successive cycle feeding, at least in part, upon the experience and results gained in the preceding development. It is that experience which in part produces the knowledgeable entrepreneur in an already difficult and competitive market. This partial dependence upon proven success as a basis for new endeavor also largely conditions industry attitudes toward innovation. ("Has it sold before in the same area"? is a favorite query by the lender.)

What is clearest about the process just described is the incredible number of both concurrent and consecutive decisions that must be made—and the large number of individuals involved in those decisions in order to bring a housing development to reality. As a result, two factors condition the peculiar nature of decision-making which evolves. The first is that each individual participant commits only a part of his total resources to a given project at a particular time. Changing market conditions; his portfolio (or job opportunities elsewhere, etc.) may make the project under consideration suddenly less than viable <u>in his terms</u>, regardless of its inherent qualities.

Thus, despite the best intentions of all concerned, any actor can pull out at any time during the development process, up to and including construction and rent up. If that role is key to the success of a particular project, its future can be foredoomed immediately.

Secondly, development is a fast-moving process whose ultimate success in large measure often hinges on a propitious response to an opportunity. Decisions are therefore often made on the basis of incomplete or uncertain information.

Where a long-lived, long-to-produce product must be created in an operational environment so completely dominated by rapid change and varying degrees of commitment, it is little wonder that the developer is loath to further compound his already considerable risk. It is also not surprising that wherever "hard" information is available to inform his decision and lessen the risk thereby, that source will be diligently looked into. For this reason, "comparables" (e.g., what kind of projects and amenities are appropriate for the target marketing area or neighborhood or what technical aspects, such as environment control systems, have already proved to be functionally effective and with minimum call-backs for a certain type of project) are critical indicators for future choices. In addition, the use of materials and subsystems capable of being committed to at the very last minute (e.g., on-site if possible) may be more attractive to the developer than those which are premanufacturered and thereby require long lead-time commitments. This is one of the numerous reasons—beside relative bottom-line costs—why industrialized building faced such difficulty in the construction

industry. While this is not a report on acceptance of innovation in the housing sector, the very delineation of some of its operative processes make quite clear the kinds of concerns any innovative technology will have to deal with in order to achieve that acceptance.

The entrepreneur builder/developer (or simply developer) as he is typically called in multifamily development, plays a central role in that process. In many ways, his risks mirror those of the other key actors and his attitudes will influence their perceptions of their own roles.

SECTION III

KEY ACTORS AND THEIR ROLES

A. OVERVIEW

The preceding description of the Housing Developer Decision System (Figure 2-2) has set the context for similar, albeit more limited discussions of the roles of other actors in the development process. In order to create a single, simplified graphic which will be usable for all of those discussions, Figure 2-2 has been reconfigured into Figure 3-1, "Building Industry Process Flow." (The focus remains the housing submarket. This generalized diagram could also support similar discussion of industry actor roles as configured in other industry submarkets. That is beyond the scope of this report.)

The linear set of actions suggested by boxes 1 through 7 has been called the "conceive/design/build process" (or C/D/B). Boxes A through D are very much a part of that process in most roles within the housing submarket. However, as suggested by Figure 3-1 and indicated at the bottom of Figure 3-2, they overlap the main stream. Also, their actual location and degree of overlap are functions of the particular project being evaluated and developed. Figure 3-1 now becomes the basis for graphic depiction of all roles. Activities that are almost always a part of the role are heavily cross-hatched, while optional or occasional, project-specific activities show a lighter hatching. Existing and additional boxes will be used as needed for further explanatory notes.

Processes A, B, and C (User Segment Analysis, Analysis of Purchaser Market, and Market Segment Screening) respectively, from Figure 2-2 can be seen to be roughly coincidental with Boxes 1 and 2 (Opportunity Assessment and Feasibility Analysis) in Figure 3-1. Similarly, Processes D through I can be seen to coincide with boxes 3 to 7, respectively, on the new diagram.

Boxes 3 through 6 also coincide with actual design and construction of the building itself and will prove to be of particular interest to SAGE.

Figure 3-2 comparatively summarizes the duration, point of entry, and nominal point of exit/re-entry of 11 key actors in the Building Industry Process Flow of the preceding Figure 3-1.

The discussion of each actor's role, overlayed on Figure 3-1, will necessarily be brief. Emphasis will be upon modest further explanation of the graphic depiction of that role, where necessary. In addition, where appropriate and "known" or "conjecturable," attitudes of the actor toward energy conservation and new energy technologies will be mentioned.

B. BUILDER-DEVELOPER

The role of this key actor has already been described and needs little additional discussion here, other than to confirm relational

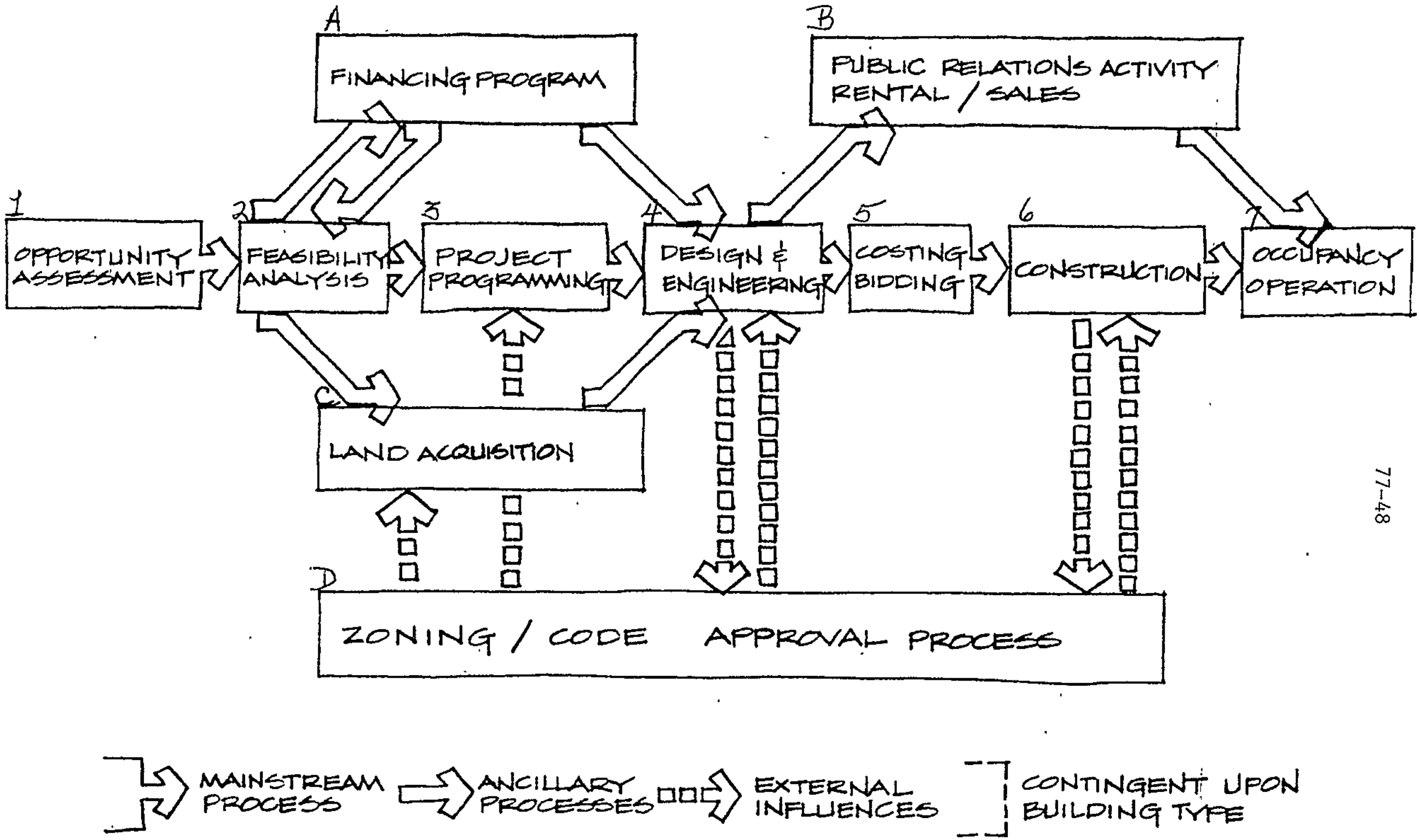
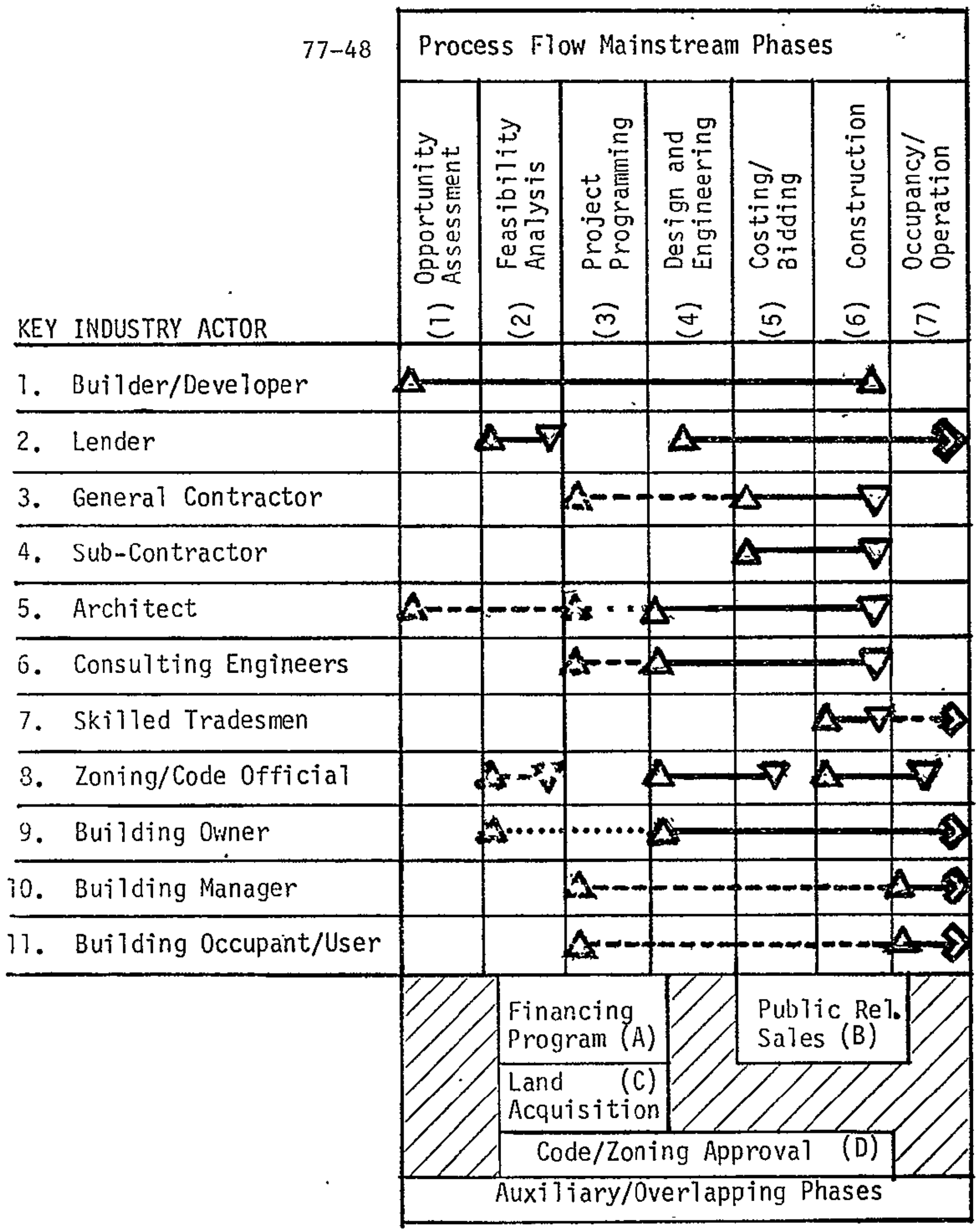


Figure 3-1. Building Industry Process Flow



Key

↑ = in △

↓ = out ▽

—— = Traditional Position

— — = Developing Position

•••• = Depending upon Business Arrangement

Note: The above seven phases encompass roughly a 2- to 4-year time span, regardless of project scale. It is the size of organizations and entities involved and the amount of resources committed to the effort which vary in order to hold total time relatively constant.

Figure 3-2. Duration and Entry/Exit Points of Selected Key Actors in Building Industry Development Process

coincidence between the two graphic formats. Heavy cross-hatching in all but one of the C/D/B steps also confirms the central nature of his role. The lighter-hatched final step indicates that his involvement in the actual rent-up, occupancy, and even operation of the finished development is a function of original planning for the project.

The series of decision-dependent steps illustrated in Figure 3-3 gives graphic emphasis to the SAGE byword, "a project is not a project until it IS a project." It also suggests why the builder-developer may be less than interested in new energy technologies for his project. Indeed he is never quite assured that tomorrow he will "<u>have</u> a project." The role of the builder-developer, like that of the architect, is highly personality-oriented. Even major development corporations may still bear the name of a flamboyant founder or have one or more such personalities as an executive(s). The developer sees his role as the provision of shelter for the community at a modest profit in return for the rather considerable risk he takes in so doing. He little understands or has patience with anti-development forces and generally feels environmental pressures to be but another name for the same resistances created to confound his work.

Thus, the developer may be conservative to a fault in avoiding the use of new energy technology and, at the same time, may fail to see possible market advantage in the use of these technologies to change the heads and hearts of his confronters and resisters. There are, however, increasing exceptions.

C. LENDER

In multifamily housing development, financing is usually provided by different institutional entities. Commercial banks provide short term or construction financing for large and small projects. Savings and loans may provide long term financing or mortgages for smaller projects. Insurance companies, pension funds and other entities do the same for much larger projects. A tentative commitment for each is required before either form of financing will be firmly committed.

As shown in Figure 3-4, the lender may or may not be consulted during initial investigation of market opportunities. He will definitely be brought into the developer's confidence during feasibility analysis for a specific project. Without at least tentative financing commitment, the project might as well be abandoned.

The lender <u>is</u> interested in promising projects. He must put funds committed to his safekeeping to work. During times of plentiful cash, he is willing to take greater risks to do so. When money is "tighter" and competition for investment dollars is greater, he tends to be more conservative. In the end, his decision is made in terms of the project's competitiveness with its neighbors in the site area. The lender also looks at the project in terms of its salability if the borrower should default. Both concerns often lead him into becoming a de facto designer—e.g., making judgments as to where and how many bathrooms a dwelling unit should have, etc.

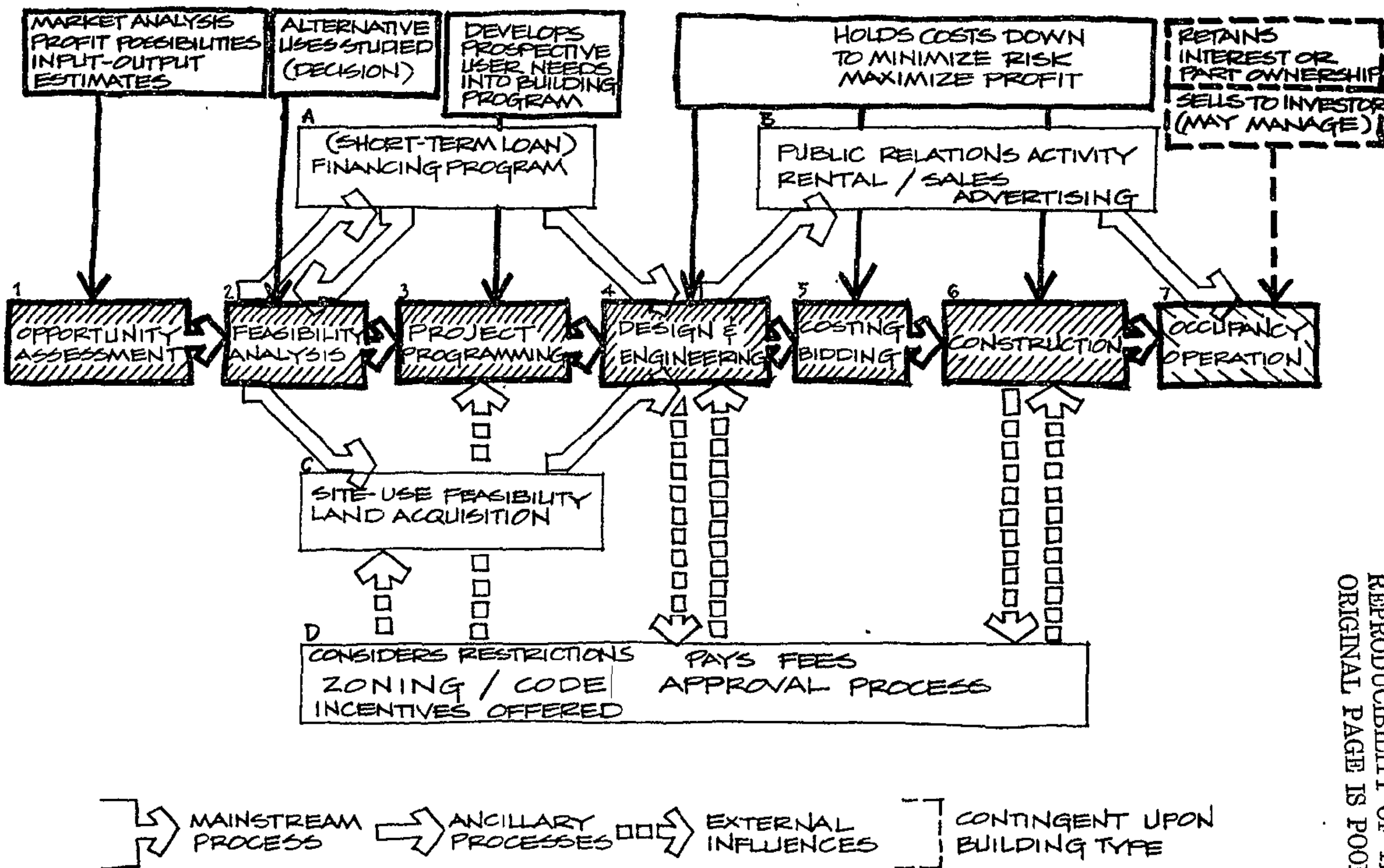


Figure 3-3. Builder/Developer

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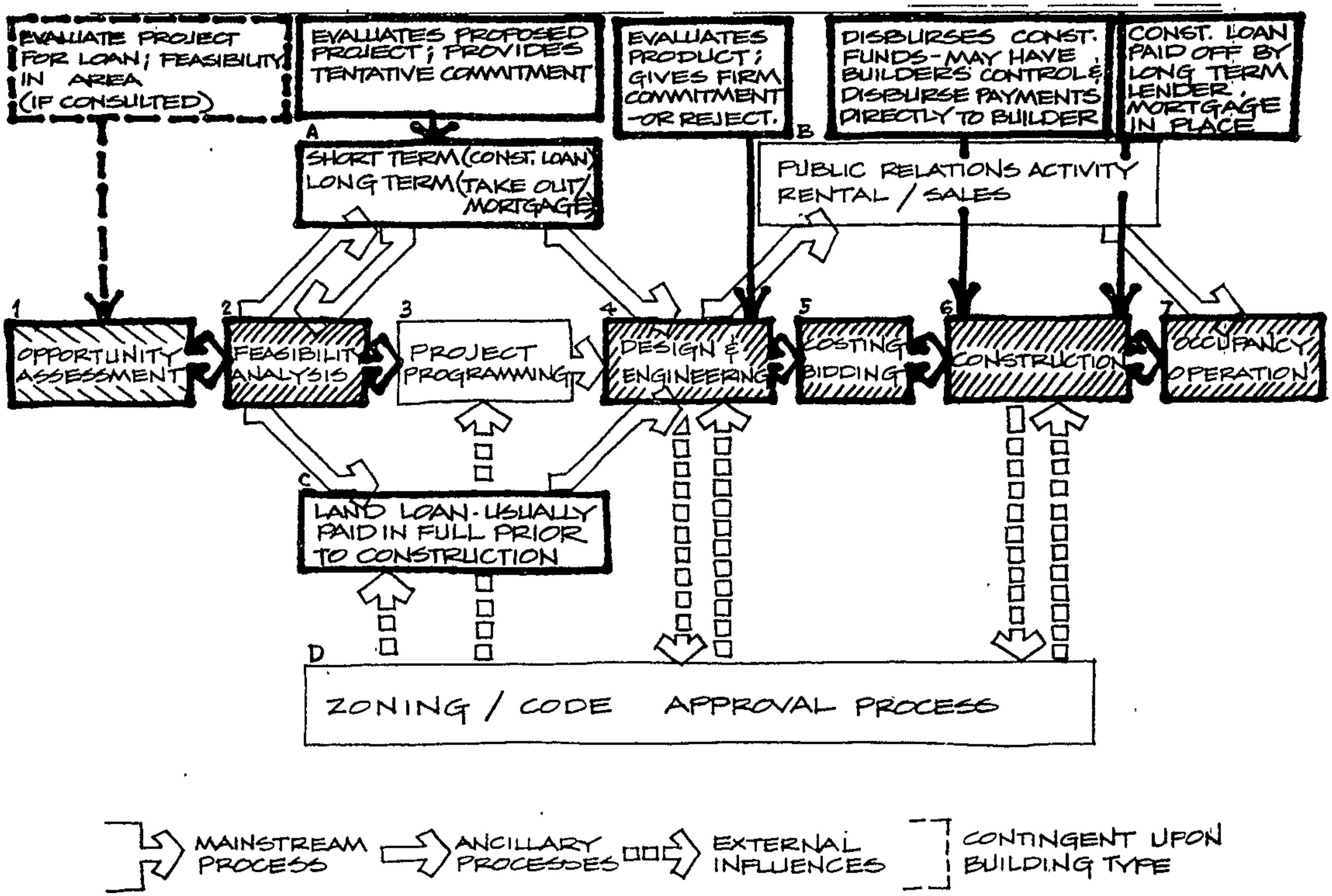


Figure 3-4. Lender Short Term/Long Term: (Often Two Separate Entities)

Final commitment is not made until all construction documents (e.g., drawings and specifications) are completed in the architect's office. This may be as much as 2 to 3 months after the tentative commitment was made. During the interim, a lender's portfolio interest may shift from the project area, etc., and the commitment could be withdrawn. This is still another reason why speed of execution is critical to the project's success.

D. GENERAL CONTRACTOR

The general contractor exists as a separate role within the multifamily development process when the developer does not fulfill that function. He may be a part of the developer's organization or he may competitively bid the project as conventional contract construction.

The advantages of the first option are suggested by the wide-hatched boxes of Figure 3-5. The general contractor is able to advise the developer during programming phases in order to insure control of construction costs from the project's outset. He subsequently works with the design consultants to maintain that control. He will even take preliminary sub-bids as required to "cost-out" selected portions of the job during the design and construction documents process. But the organization must have projects in construction more or less continuously in order to keep the contractor gainfully employed.

The second option, competitively bidding the project upon completion of all documentation, is the typical industry method of determining a firm and total project cost. However, cost "surprises" may occur when the bids are opened. A middle option that combines the best of both contractual forms is the negotiated contract.

The general contractor's role may be seen as a subset of the developer's. That is, for the construction process proper, he too is an organizer and a marshaller of necessary resources to do the job. He has little capital invested in equipment, etc.

Because he must guarantee the project for a year, the general contractor may have some trepidation over the incorporation of relatively untried technology. More important, he will chance no piece of equipment or subsystem whose delivery at the specified moment in the construction process might be in doubt.

E. SUBCONTRACTOR

The relationship between the subcontractor and the general contractor is similar to that which exists between the general contractor and the owner or developer. Regardless of whether the contractor is part of the developer's organization, bids the job independently, or works on the basis of a negotiated contract, he will take sub-bids from a selected group of subcontractors for each major part of the work.

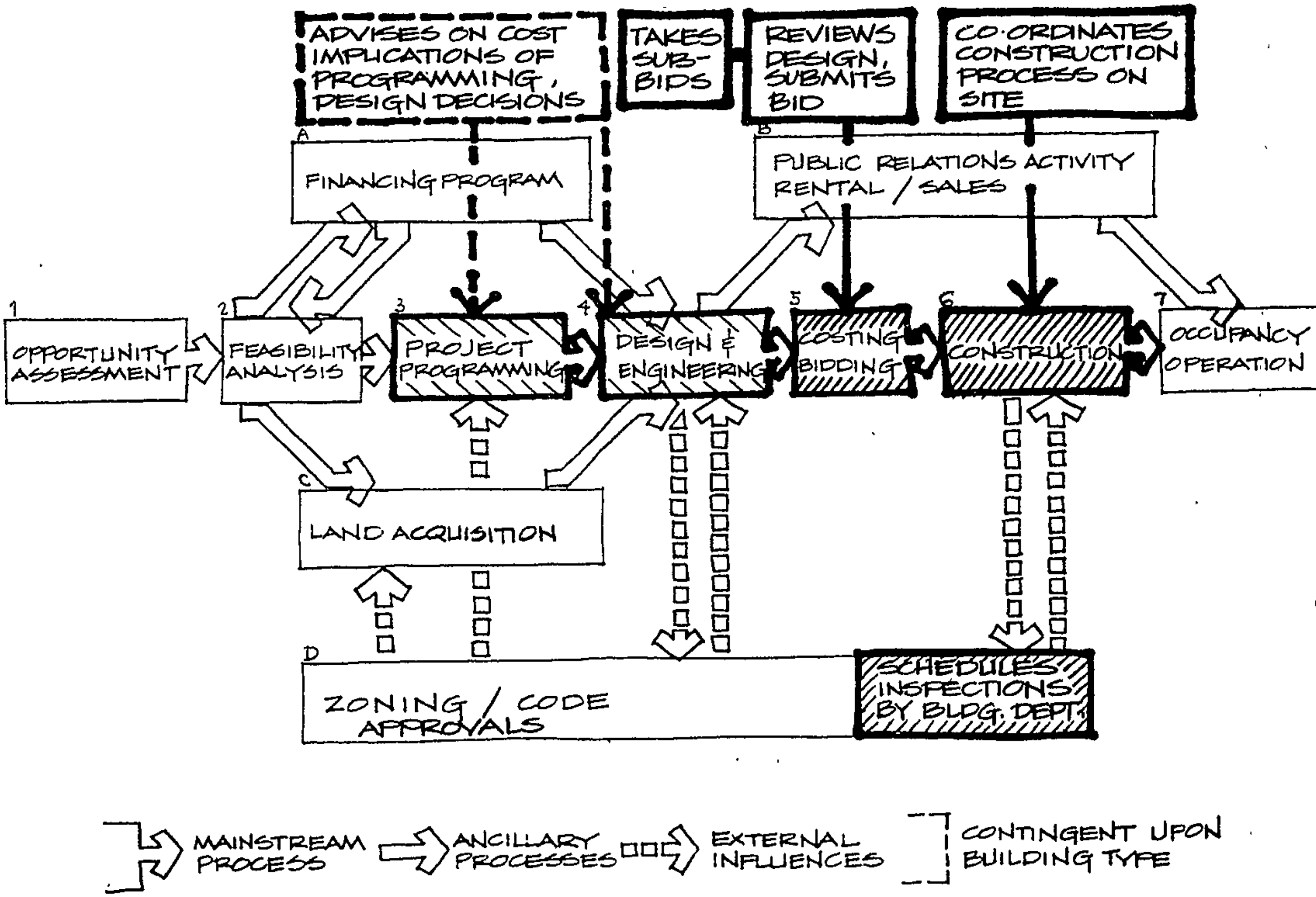


Figure 3-5. Building Industry Process Flow: General Contractor

For this reason, the subcontractor rarely enters the picture prior to the bidding process (Figure 3-6). His concerns over delivery, warrantees, etc., are similar to those of the general contractor's and for much the same reason.

However, the sub may be much more attuned to new work opportunities promised by recent or alternative energy technology. This would depend upon the match between that technology and jurisdictional union rules and agreements under which he operates. Thus, the plumbing contractor would be interested in the opportunities promised by SAGE...as a "wet" system. But the sheet metal contractor would be seriously interested only in solar-assisted systems using air as a working medium.

F. ARCHITECT

The architect would prefer to enter the development process early...e.g., when alternative sites are being considered. He has the capability to do so under established "extended services" contractual arrangements. He may also have unique contributions to make in this area (especially in selecting sites responsive to microclimatic design, etc.). In the normal multifamily development process he is more typically commissioned after most of the programmatic decisions have been made (Figure 3-7).

Once, architects designed less than 5% of the nation's housing which was primarily single family and usually developed under the "cookbook" processes of state subdivision land planning acts. Usually "drafting services" and building designers "drew up" the actual housing itself. Today, much low-rise multifamily development is in the form of Planned Unit Developments (PUD). In producing a PUD, the developer must validate his proposed use of the land in order to gain approval of local bodies. He often will maximize his chances in this regard by hiring the best design talent he can afford—not only architects, but engineers, landscape architects, etc.

The architect articulates the verbal results of the entire development process up to this point. Three-dimensional preliminary design concepts are then transformed into construction drawings and specifications. If the project is to be competitively bid on a lump sum basis, he assists the developer in next evaluating and selecting the best bid and the winning general contractor. During construction he does not supervise the job, but "administers the construction contract to insure compliance with the intent of the documents"—to do otherwise would imply control and therefore responsibility for construction. The latter is the provence of the general contractor via terms of his contract with the owner or developer.

G. CONSULTING ENGINEER

The dashed box used in the continuing series of diagrams in this report indicates a role component that is contingent on building type. This allows it to be a background graphic for more than one submarket.

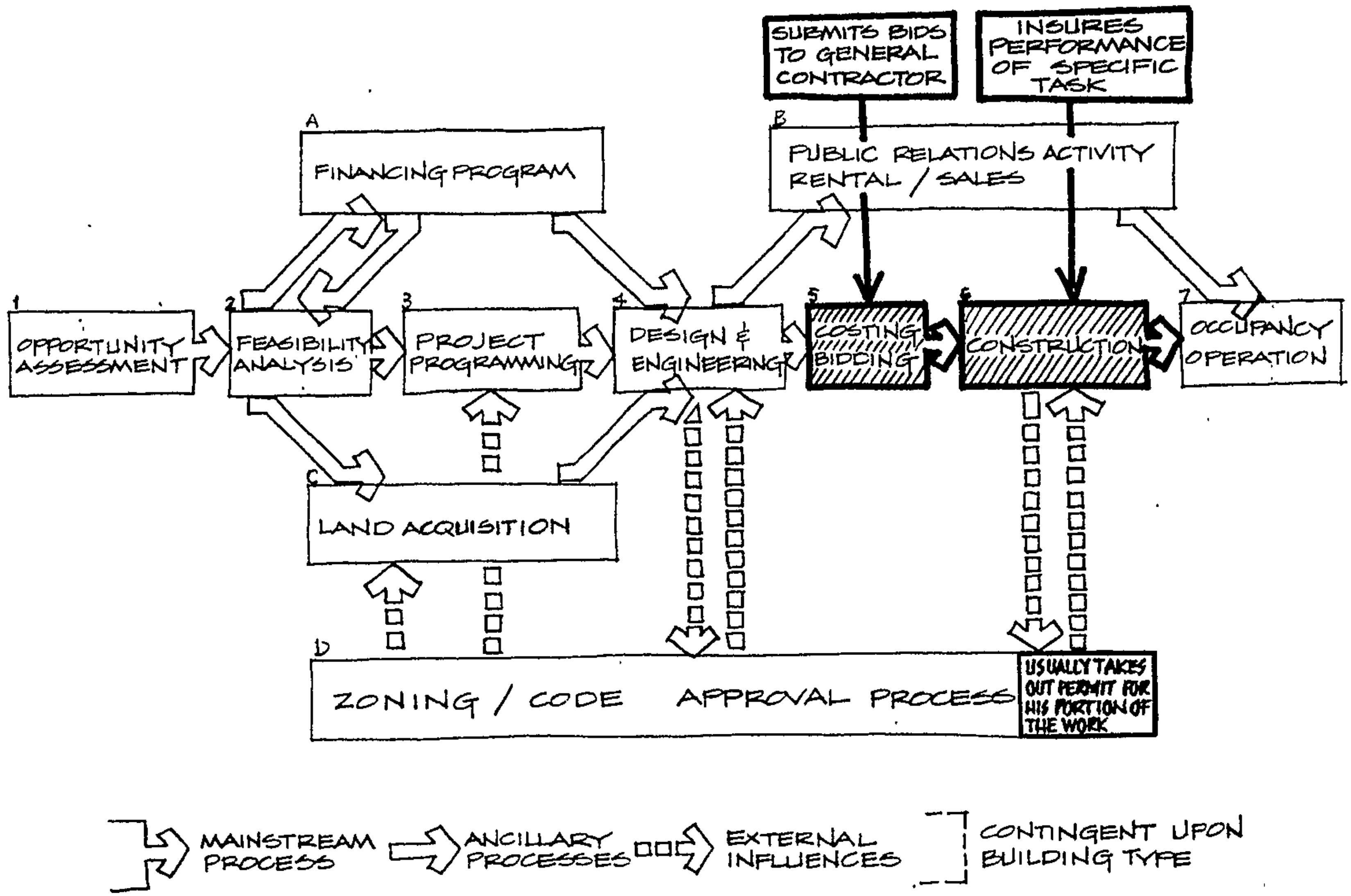


Figure 3-6. Building Industry Process Flows: Subcontractor

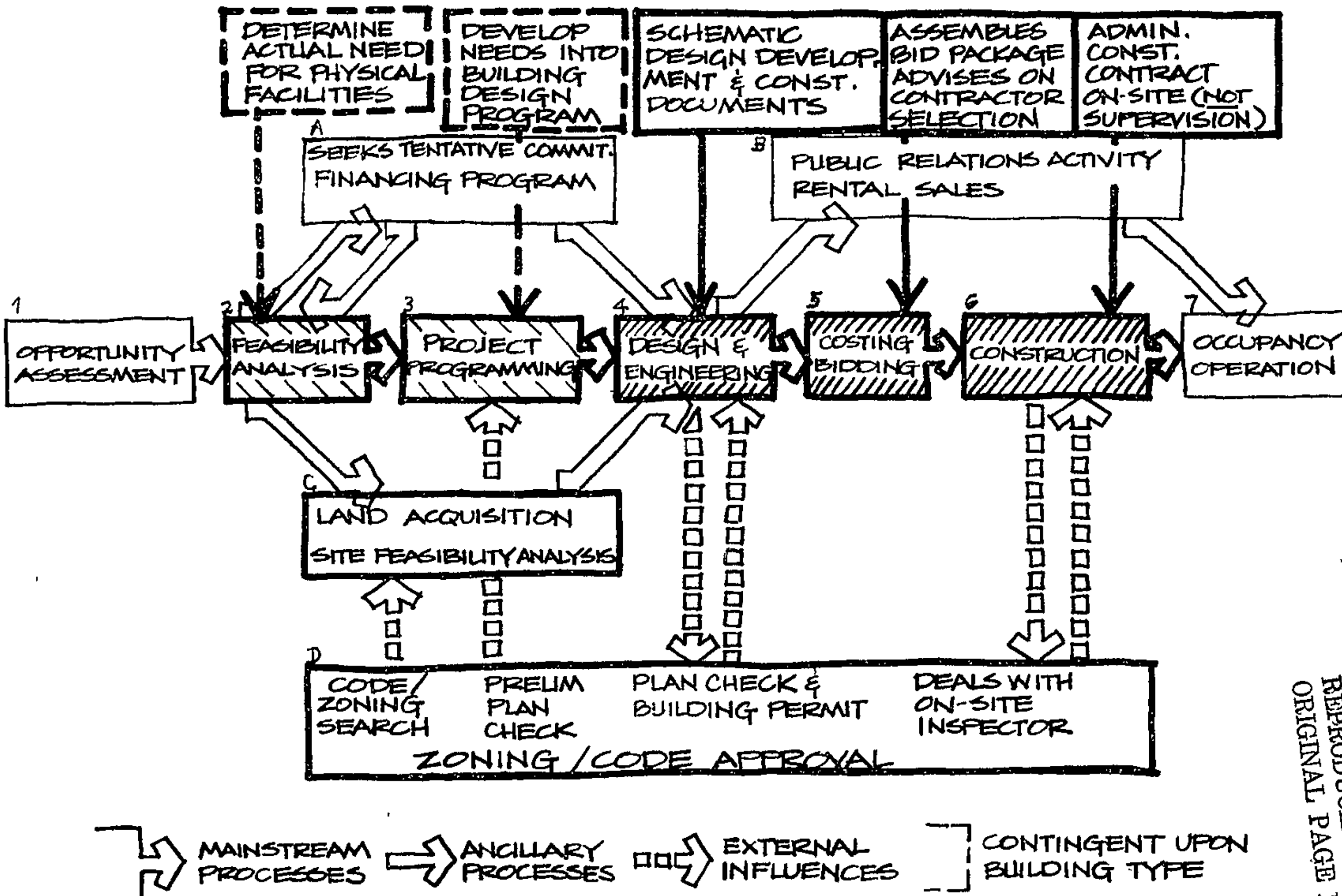


Figure 3-7. Building Industry Process Flow: Architect

Nowhere is this truer than in Figure 3-8, which shows the consulting engineer as "advising on engineering choices" during "project programming." This may occur in the programming of some building types... but rarely in low-rise multifamily garden apartments. This is because such projects are essentially conventional in all systems used. In fact, consulting engineers may not even be involved at all in small-to-modest-scale multifamily projects. The probability of their involvement ranges from highest for structural engineers, to mechanical, and least for electrical engineers. Where engineers are not involved in a project, their "function"...much simplified...is executed by the subcontractor on the job. For example, the plumber may use preprinted charts that incorporate industry or specific manufacturer rules-of-thumb to size heating, ventilating, air conditioning or domestic hot water systems. Structural elements may be strictly wood-framed, conforming to Type V (timber construction) methodologies incorporated into every building code. Mechanical and electrical systems may be "designed" entirely according to code by those subcontractors. The practice is prevalent even in two-story garden apartment projects of 100 to 200 units. The architect's specifications may actually direct the "sub" to "size and install according to code."

Where an engineer is on a project, 95% of the time he is hired by the architect, responsible to him, and therefore obviously brought in even after the architect...e.g., during "design and engineering." Usually the basic design has been determined and he is asked to "make it work" in terms of his specialty.

H. SKILLED TRADESMAN

Skilled on-site trades include carpenters, electricians, sheet metal men, plasterers, drywallers, plumbers, painters, masons, concrete finishers, roofers, etc., as well as specialty installers and laborers. They may or may not be unionized. The "open shop" and "right-to-work" laws in dispute in many states are primarily directed at on-site construction. Currently, most urban-area construction is unionized.

The major protective functions performed by the union have to do with wages, benefits, the designation of who works on what project, which trade will control what work (jurisdictions) and what "kind" of work will be "allowed" on the site. The latter two are of direct interest to any efforts at instituting change or new products in on-site construction. The issue of which trade shall install a system and whether a preassembled system may reduce work available to the tradesman may, in large measure, impact its acceptability for use.

Each trade is managed on the job by a subcontractor who often has "come up from the trade" into management and then as an independent businessman (see "E: subcontractor"). The tradesman working for that "sub" can perform a very limited set of functions while taking care not to interfere with the work of another trade. Thus, each is "scheduled-onto-the-job," leaves when his work is through (to a point where another trade must get involved) and may then return when the job is ready for further work by him. The work proceeds essentially in

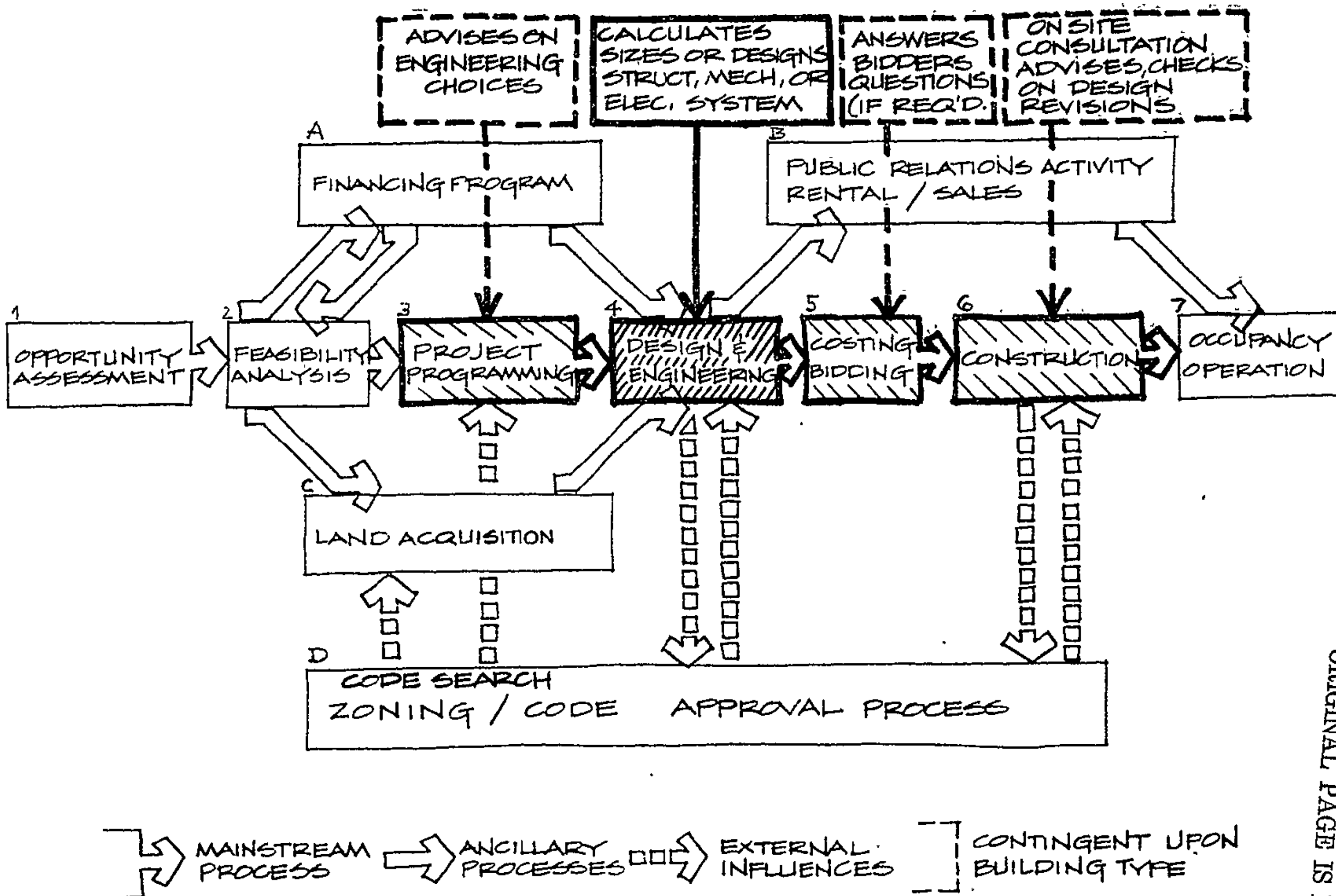


Figure 3-8. Building Industry Process Flow: Consulting Engineers (Structural/Mechanical/Electrical)

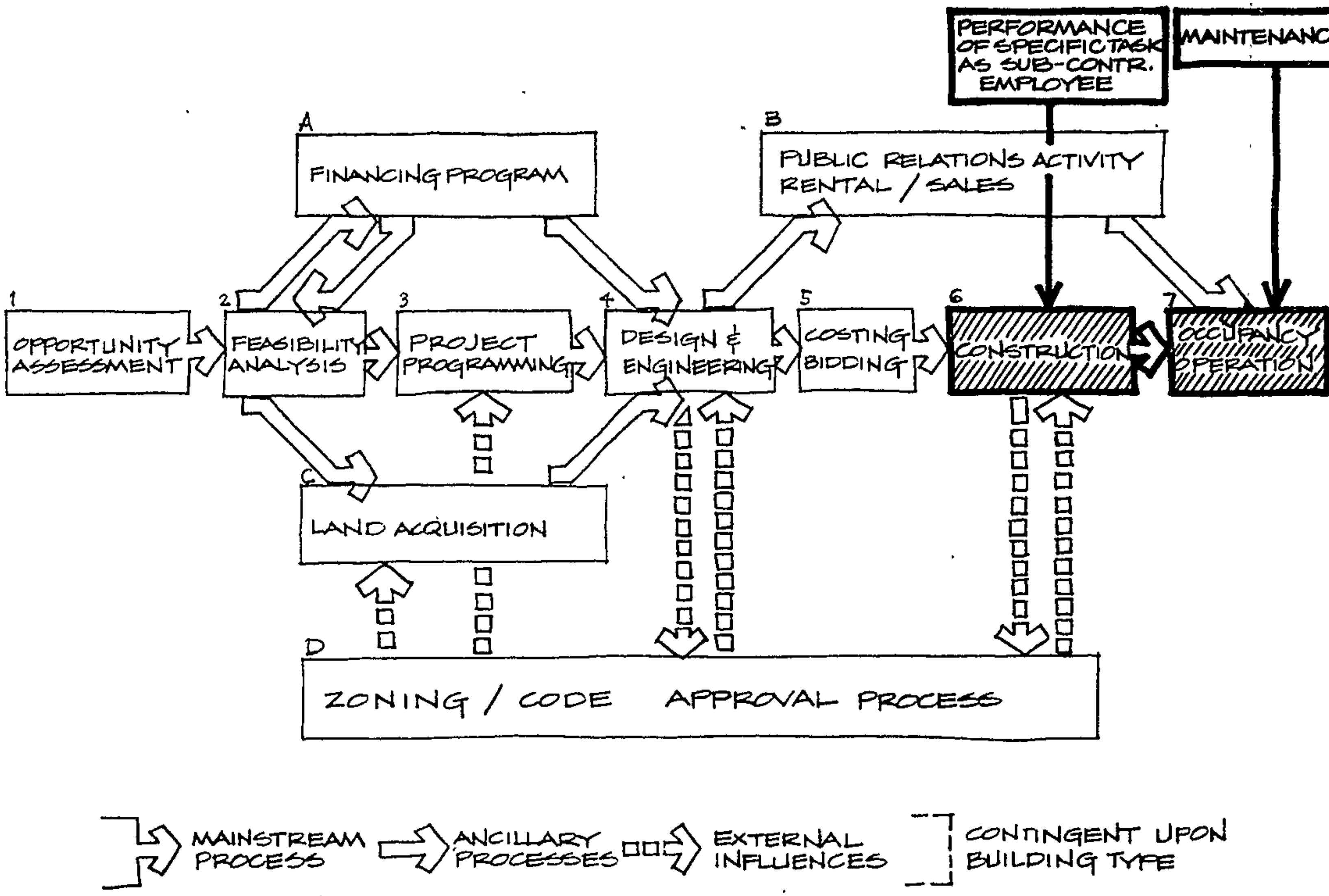


Figure 3-9. Building Industry Process Flow: Skilled Tradesman

serial fashion, although much of the time there is more than one trade actively working on the job during the construction period.

Pride of "working with one's hands" still persists in the trades, even in those that are actually highly mechanized. Doing a "good job" for a "good building" is still a serious concern for many.

I. ZONING/BUILDING CODE OFFICIAL

Two related but nonetheless distinct roles have been combined on Figure 3-10. The zoning official is an employee of the local planning department and the code official (counter engineer, plan check engineer, inspector, administrator, etc.) is employed by the local department of building and safety. Most incorporated cities and towns as well as unincorporated (county) areas in this country have one or both departments. If not, they may contract for those services from neighboring communities who do.

The zoning official is concerned that uses proposed for undeveloped land or changes in use for developed parcels conform to the zone in which the property is located (e.g., to the local land-use plan as reflected in the zoning ordinance). The building official is concerned that the structure(s) to be placed on that land conform to the local building code or localized version of a regional model code if in use (e.g., that public health and safety is not endangered through unsafe design or construction practices).

The zoning official may be consulted during "feasibility analysis" in regard to land use options available. Otherwise, he first sees the project during the "design and engineering" phase, "confirming compliance" by "zoning in" the project when building permit plan check application is made. The building code official may also be consulted during the preliminary phases of "design and engineering." This is because any building code (other than a performance-based code), no matter how comprehensive, cannot cover all possible building design and construction variations. Therefore, the architect and often his consulting engineers consult "over-the-counter" with the building department to gain preliminary opinion on what they have in mind (although that opinion is only advisory at this early stage).

The process of permit application, plan check, permit issuance, and on-site inspection during construction is graphically depicted in the next section (as are processes for implementing innovation in both zoning and building code regulation).

J. BUILDING OWNER

The initial "dashed" box at the upper left in Figure 3-11, "makes decision about participation in project...", sets the stage for the following discussion. If the developer is putting together a project for a preidentified owner or if he is developing "for his own account"

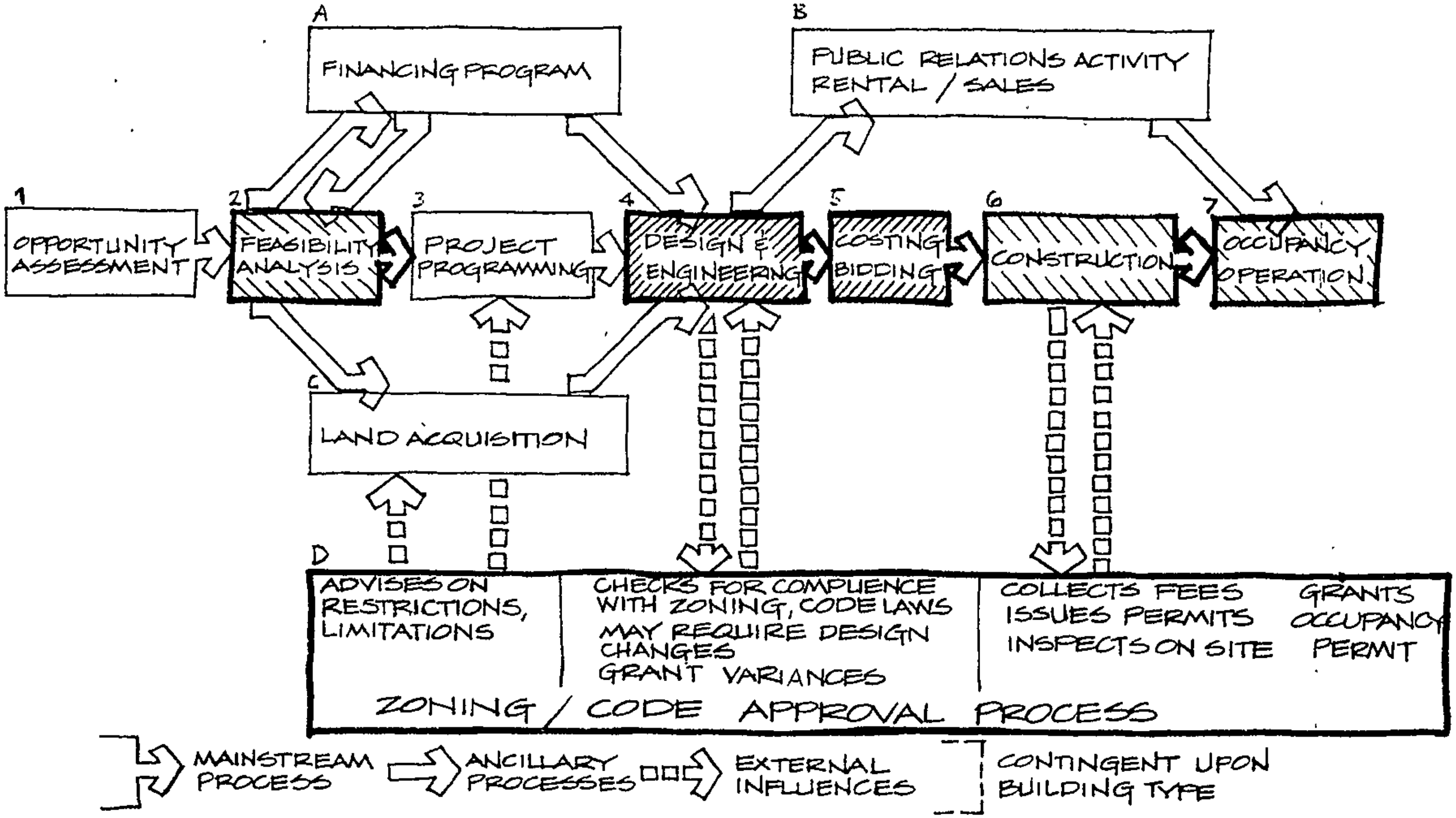


Figure 3-10. Building Industry Process Flow: Zoning/Building Code Official

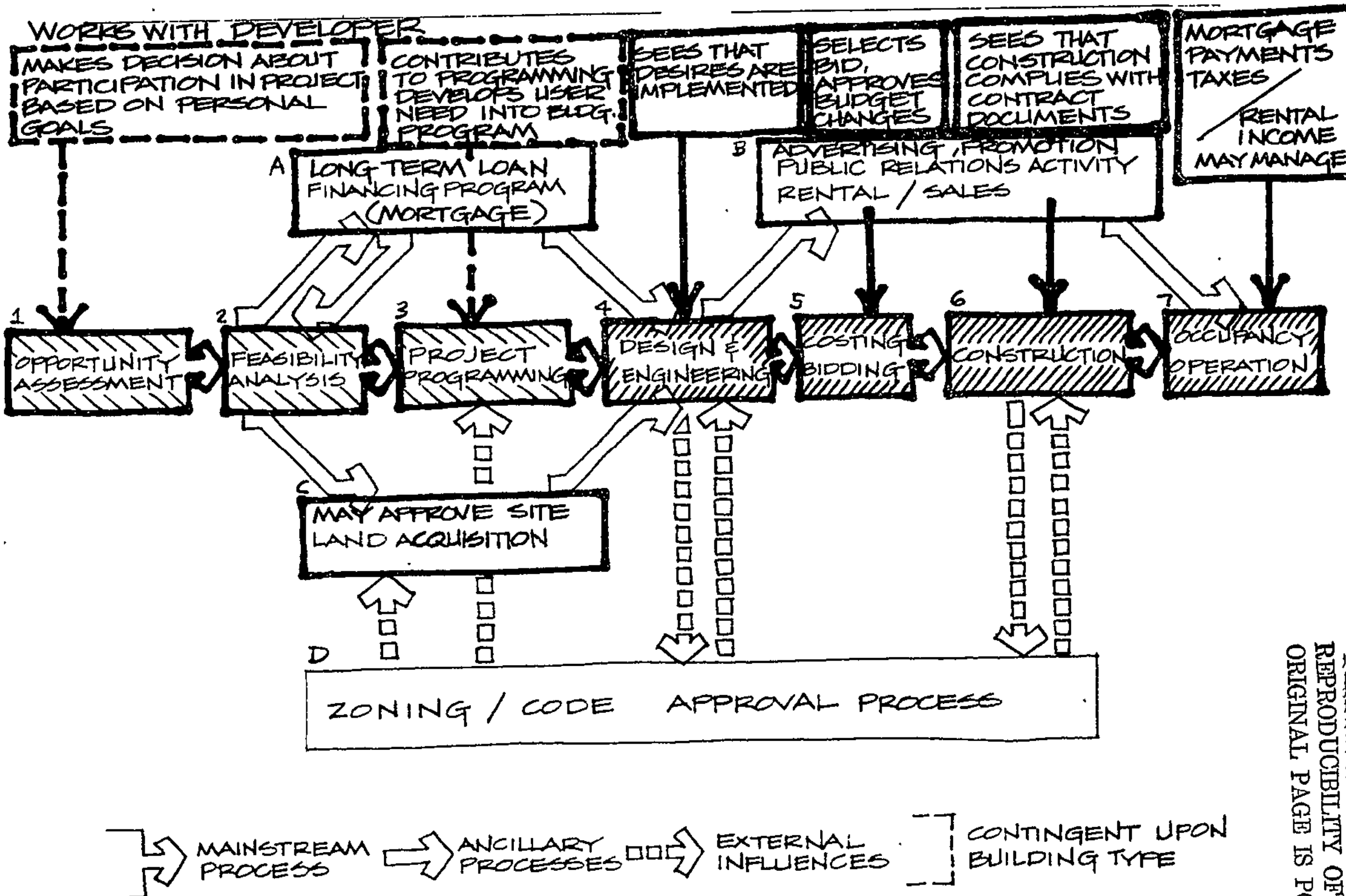


Figure 3-11. Building Industry Process Flow: Building Owner

(e.g., his own investment, especially on a long term, income basis, rather than strictly speculative or for tax advantage) then the "owner" may indeed be involved to the extent shown on the figure. The same would be true if an individual client/owner hired an architect directly to design either type of multifamily project for him. In both cases, what evolves is the traditional owner/client-design-and-build team relationship typical to building projects of all types (commercial, residential, institutional, industrial) that are custom-designed.

If the owner is dealing with a developer who in turn hires the architect (or who may be on the developer's staff) more than likely "turn-key" is involved—the design and production of a building completely handled by a single "supplier." The owner may specify any two of three parameters for his turn-key project; cost, quality, or scope. Construction is too complex, drawn out, and indeterminate a process for even a packaged builder to guarantee all three without at least some decision-making leeway. However, an owner may hire an architect to design a building exactly to his needs but within the funding (budget) he has available. The same three concerns of cost, quality, and scope are of equal importance here—but the architect AND the owner together exert continuous say (if not always complete "control") over each. In both cases, the costs and benefits of innovation of any type are integral project issues to be considered on individual merit.

K. BUILDING MANAGER

As in the preceding figure, the upper dashed box in Figure 3-12, with the phrase "if consulted" tells the story. Logically, experienced building managers would have as much if not more than owners to say about necessary functional (operational) aspects of a proposed multifamily structure. Their input would have to take place during programming, with possible detailed follow up during design and even construction, if it is to be timely and effective.

Unfortunately, until recently this simply did not occur. Multihousing was not alone. It was true for building of all types—even commercial and institutional clients with major, on-going construction/expansion programs. The actual detailed performance of a building more often than not failed to find its way into basic planning for later projects in most building-type job markets.

In recent years, this situation has significantly changed. A new, almost separate area of study for institutional buildings — "facilities procurement" — has produced specialists and a growing, specialized literature. In multifamily housing, the industry's own press has urged participants to "involve your manager <u>early</u> in the design process of your next project—it will pay off."

The process and product of building will be improved by both kinds of efforts. However, a secondary impact will have to be watched for. The manager, like the framing carpenter often can not see "beyond the nail he is driving." Effective management is essential to any project

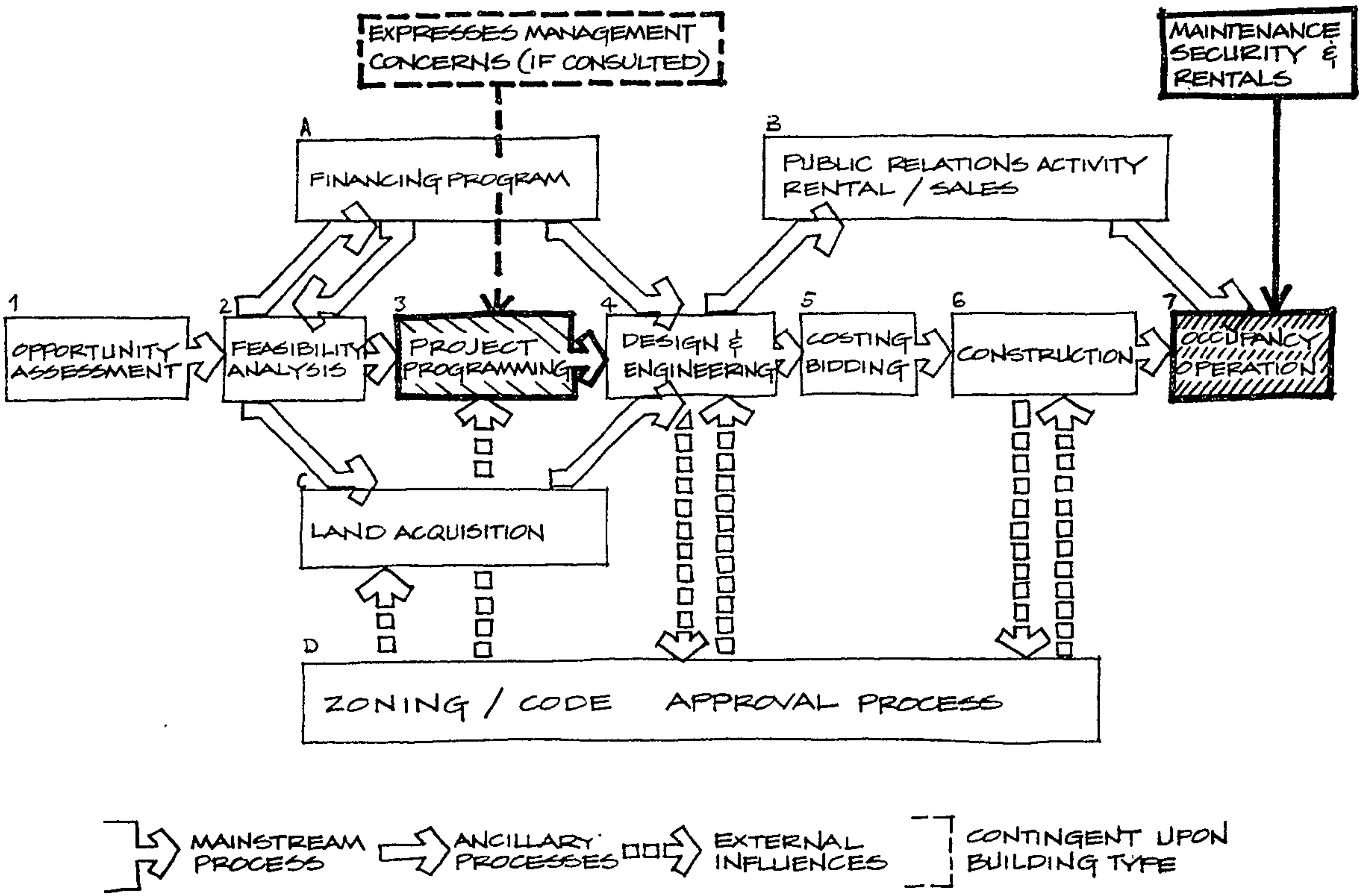


Figure 3-12. Building Industry Process Flow: Building Manager

and can often spell the difference between success and failure — but it is not an end in itself. To be governed only by past experience can limit the architect or the developer's ability to respond in innovative fashion to new opportunities.

L. OCCUPANT/USER

As in the two preceding charts, "if consulted" largely governs Figure 3-13. In the past, the occupant was not consulted before the fact because he simply did not yet "exist." The owner, developer and/or their architect planned for the "anonymous user." In reality that user is not entirely anonymous. Marketing plays a big role in the developer's activities and occupies a great deal of attention by publications and other communications channels serving him. He knows "what is selling" in a given area. It is the truly "successful" entrepreneur who can sense what will be selling a few months or even years hence.

With the advent of increasing community resistance (environmental, anti-growth, etc.) to more and more projects, soon builder/developers may HAVE to find effective means to involve the eventual buyer or tenant directly in the planning and design process for new housing projects.

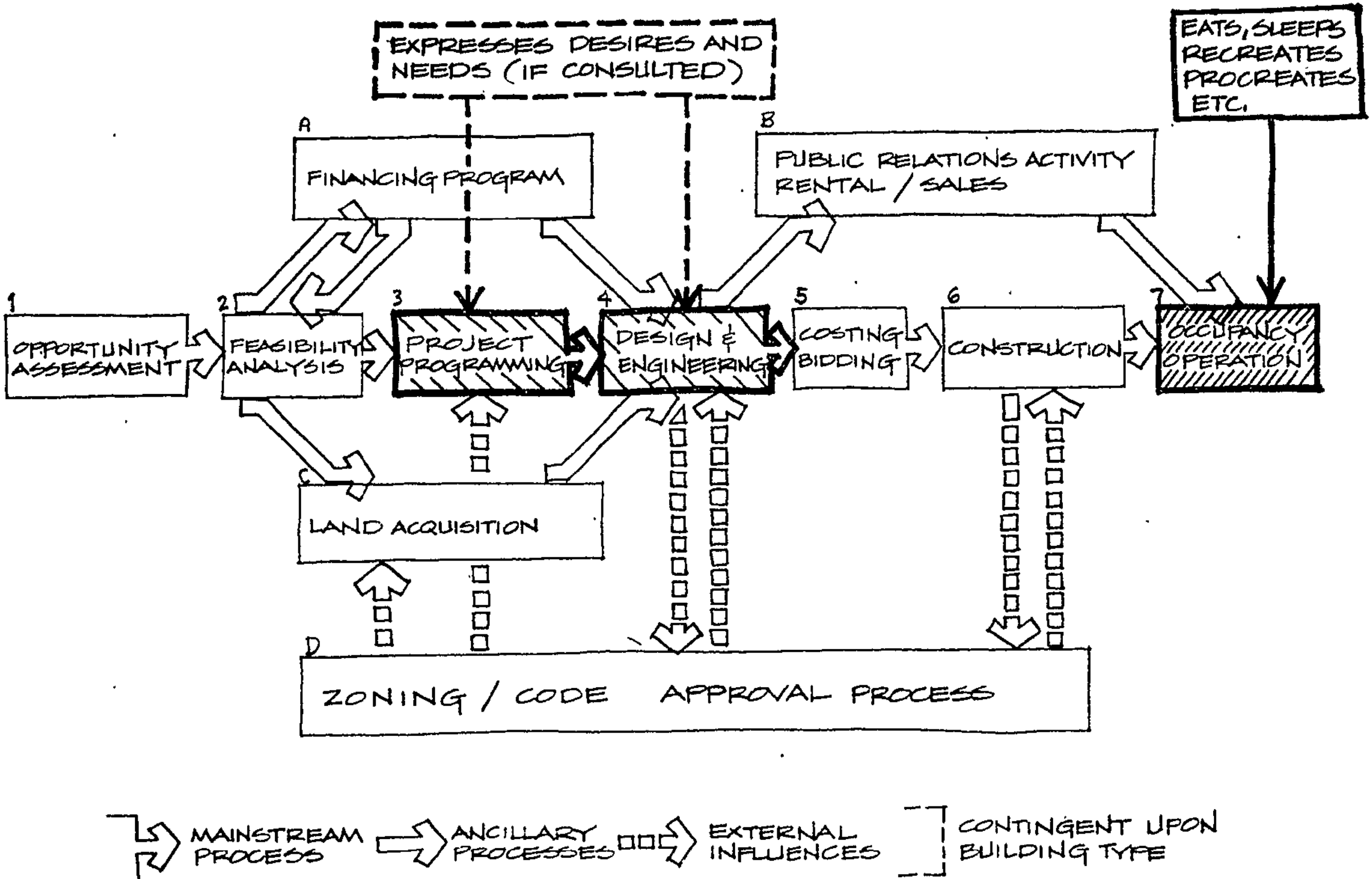


Figure 3-13. Building Industry Process Flow: Occupant/User

SECTION IV

BUILDING CODE AND ZONING ORDINANCE APPROVAL PROCESSES

A. OVERVIEW

A dual tradition has dominated use of land in this country since before the American Revolution. The first, a fundamental constitutional principle, is private ownership of land. The second, is governmental intervention in order to guide the direction, type, and speed of development of that land by its owners. The land usually remains in private possession. Three of four basic regulatory tools are an extension of the police powers of the state to local jurisdictions in order to achieve that control. The transfer of those "powers" occurs via various model enabling statutes that now exist in all 50 states.

The first tool, building codes, regulate how buildings are to be constructed on individual sites in terms of health and (primarily fire) safety. The second, zoning ordinances, regulate how individual building sites or lots are to be developed or used, in terms of what can be constructed on those sites. They also regulate building bulk, parking, and indirectly, population density. The third tool, subdivision acts, are usually state laws, locally administered, that regulate how larger tracts of lands are to be broken up into individual building sites. They also designate what services or amenities subdividers must provide to the sites, and to the development as a whole. The fourth tool, "Covenants, Conditions, and Restrictions, (CC&Rs)" are an effort by the subdivider to retain control of the direction of his development in terms that he believes will be attractive to his buyers. Foremost in this approach is his assurance that their investment will be protected from "inappropriate use" by their neighbors. This is achieved via "CC&Rs" which are deed restrictions that "run with the land." They are conditions of purchase to which buyers and sellers of individual lots agree during original and all subsequent sales of individual parcels.

Subdivision regulations are not of direct concern to the future of Project SAGE. However, CC&Rs can have utmost significance to acceptance of the potential SAGE product line and therefore its marketability to multifamily developments. That is because they generally forbid visible location of mechanical equipment on rooftops. Current experience indicates that solar collectors are being considered as mechanical equipment by the "art" or "architectural" juries who sit in such developments in order to enforce CC&Rs and rule on individual "infractions" thereof. For this reason, a renewed interest in court action to test their legality has developed and such actions are now under way. This activity should be monitored with results reported separately. Even more intense interest has developed in "urban sun rights." The individual property owner's "right to light" has precedence in English, not U.S., common law. Tentative ordinances have been advanced in various communities and are destined for similar judicial tests. The entire subject has been, and will continue to be, the subject of

numerous reports as judicial action develops, including elsewhere within Project SAGE. Thus, neither will be considered further here.

Zoning ordinances are of particular interest to SAGE because they control building heights and establish required side and front yards, etc. — thereby creating a "buildable envelope" for each site. They may largely delineate what can be located where within that envelope. "Yard regulation" in turn determines what can be located between that envelope and the site boundaries, or property lines. Yard regulations have significant implications for SAGE as to collector and storage tank location. However they appear to pose no undue difficulty in this area. (At least, no greater than other issues to which the architect must respond in fitting his scheme to the zoning "envelope.") Understanding that "envelope" in turn allows one to realize what type of apartment building may be built in each zone and to match SAGE variations to each.

Building Codes are of even more specific concern to SAGE because of their direct structural, electrical, and mechanical control over the design of building systems and materials used therein. Content and organization of building codes has been the subject of both SAGE and non-SAGE efforts in the past and will not be discussed further here. Rather, the emphasis in the present section is upon the building code and zoning ordinance <u>approval</u> processes — the means by which conventional as well as innovative building designs, systems, and materials are implemented in actual projects.

Zoning ordinance and building code approval processes are appropriate to the present report because they are symptomatic of the kinds of constraints that the owner or controller of any building site must face each time in the development of a particular site.

Even though the developer may do a preliminary code and zoning check before commencing development (as described earlier), he is never quite sure of <u>final</u> approval until he has invested a fair amount of resources in a given project. To the extent that his proposed use of a parcel differs from the zoning in place or to the degree that his architects and engineers propose utilizing innovative (perhaps money or energy-saving) materials, systems, or techniques of construction that differ from those already code-approved, he may face increasing uncertainty and at the very least, longer delays in "for approvals." Both realities help to explain key actor reticence to consider any new technology that may increase delay and risk. Zoning and building code regulations are self-executing, noncompensative, and negative in approach. That is, they establish beforehand exactly what is permissible — down to the last detail, and are expected to be hewed to in detail. Administrative relief is an adjustment process based on proving hardship and is determined on a case-by-case basis. Neither form of regulation compensates the owner for expenses incurred in responding to them or for losses the owner may believe have been incurred in the earning value of a property or extra costs for its

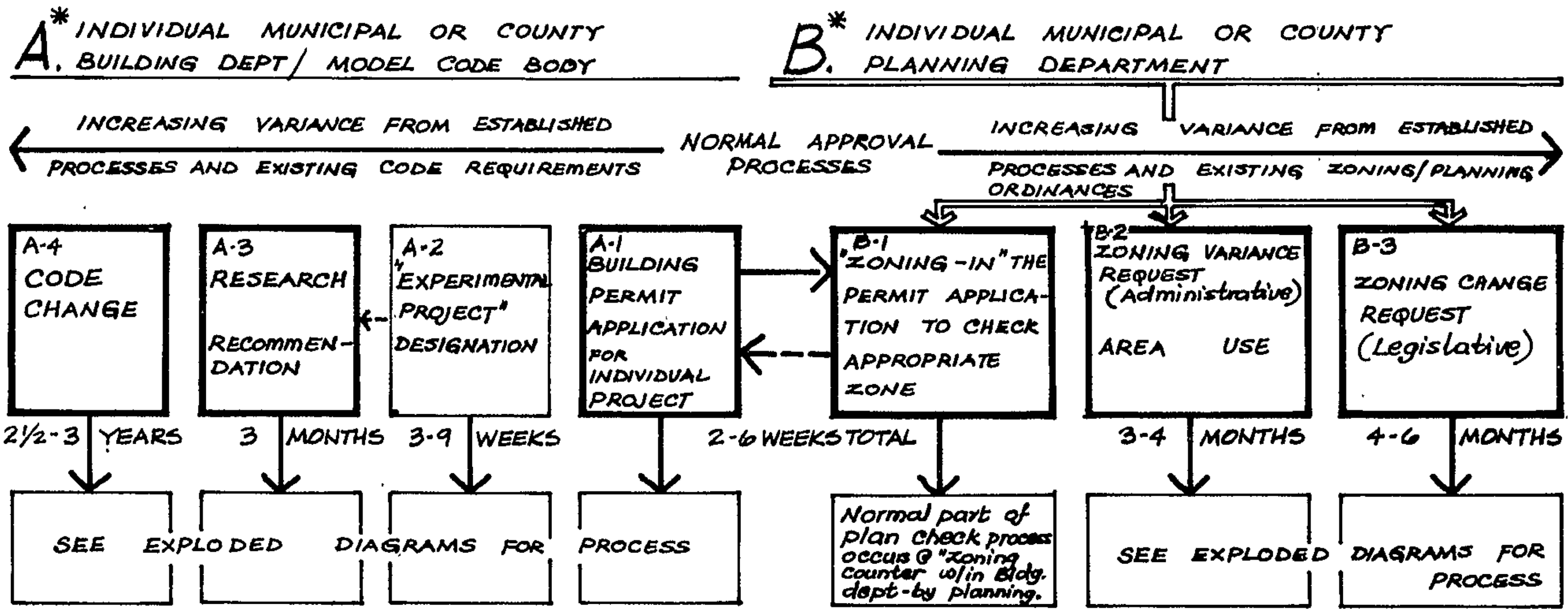
development, due to such regulation. The regulations are negative in the same sense that "nuisance" regulations are applied to keep out the bad rather than to achieve the good. Thus, quality levels can be beyond and even directly different from "health and safety." They are part of the developer's initiative.

During the 1960s the phrase "protect the public welfare" was added to "health and safety" as objectives in the preambles of most zoning ordinances and building codes. At the level of zoning and subdivision regulation, this has facilitated entry into land use control of local community concern over availability of resources (water, natural gas, electric power) and the provision of services (sewer, schools, etc.). It has led in many cases to restricting further development, in the name of those concerns, by many communities. New "super bodies" have been created (and sustained) by society to regulate development that extends beyond the boundaries of any one community or to protect a larger, common value. The California Coastal Zone Conservation Commission is a most important example.

In the same way, "promoting the public welfare" has led to introduction within the building codes of energy-use-limiting restrictions on building design and materials. The State of California "energy insulation standards" for residential construction are of particular importance in this regard. However, as California residential energy design standards are administered by local jurisdictions in the same manner and as a part of local building codes, the following discussion of approval processes will apply equally to them as well.

As can be seen in Figure 4-1, this section of the report is organized in terms of zoning and code approval processes that cover increasingly nonconforming activities from the established norm in each case. At the center is the process by which a normal building permit for a conventional project is sought, during which its proposed site is routinely checked for conformance with uses allowed in that zone. The other extremes in each case are actual changes to the building code (A-4) or zoning ordinance (B-3), respectively. In between are processes which allow experimental use of a building material, system, or process (A-3, A-4) or variance in the use of a piece of property, on a permanent or conditional basis (B-2). Both types of intermediate processes often are useful, even necessary preparatory steps to subsequent actual code or ordinance change. As might be expected, required direct (approval/testing) costs and indirect (consultants) costs and time (which is literally money to the developer) increase as one deviates from the standard approved process — Figure 4-1: A-1/B-1.

Discussion of individual approval processes which follow are based, where appropriate, on one or a combination of zoning and code (local county, model) regulations in use in the Southern California Gas Company Service territory. As is well known by now, the specifics within those codes and ordinances may vary in minor and major ways between individual, even contiguous municipalities and/or unincorporated areas within the territory. However, the approval processes involved are usually enough alike to be discussed in generic fashion. (Most



* Letters and Numbers on this and subsequent figures in the Code/Zoning Series are for keying and discussion purposes only. They are NOT intended to suggest a hierarchical character for what are actually parallel and generally independent processes.

Project SAGE: Schoen/Iyengar/Benson, School of Architecture and Urban Planning/UCLA for the Jet Propulsion Laboratory and the Southern California Gas Company

Figure 4-1. Major Building Code and Zoning Ordinance Approval Processes

Figure 4-1: A-1. Building And Safety Department - Building Permit Application Process

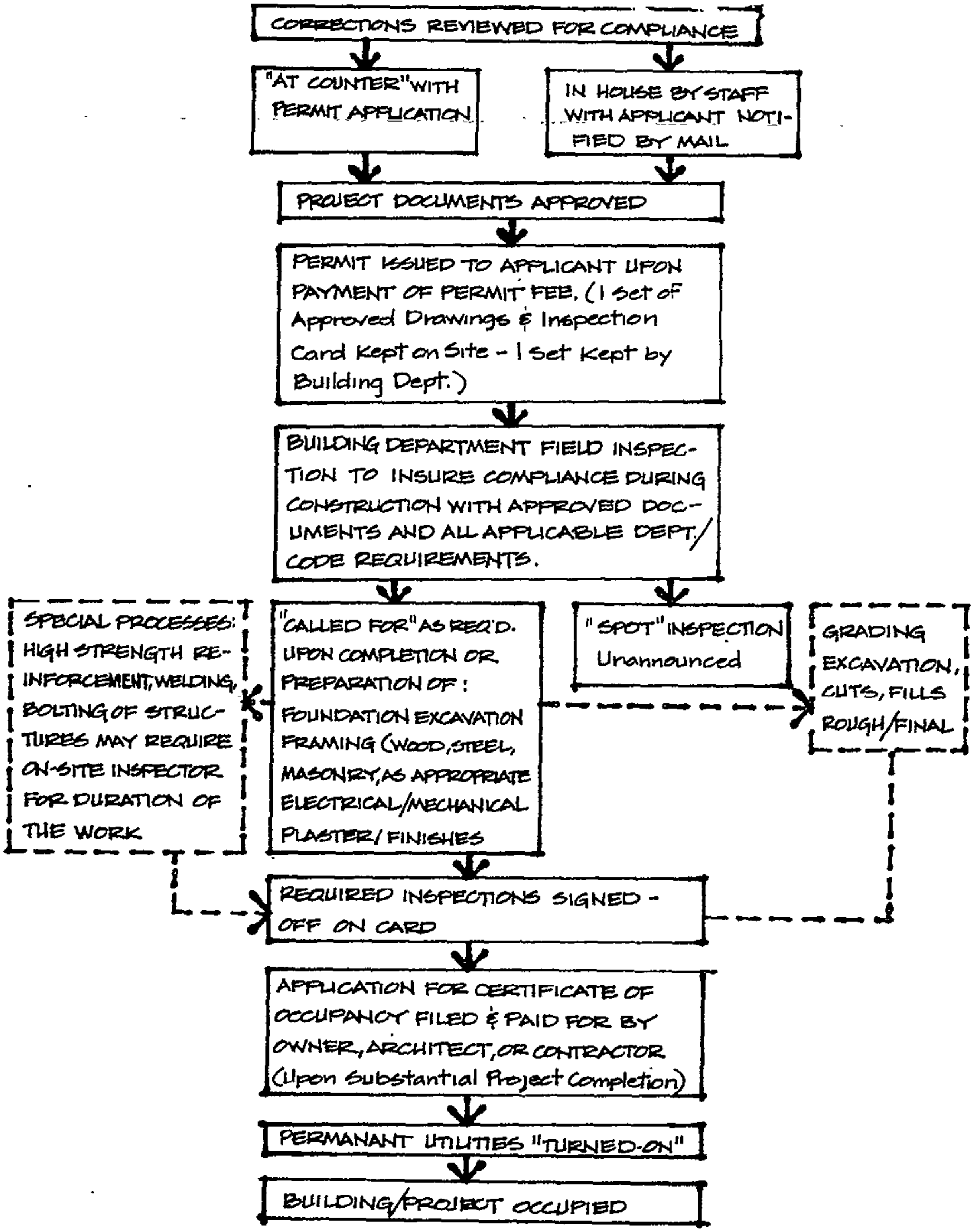


Figure 4-1: A-1. Building And Safety Department - Building Permit Application Process (Continued)

of the diagrams are self-explanatory. Therefore, accompanying text will be minimal.)

B. BUILDING CODE APPROVAL PROCESSES

The conventional building permit application process is basically a five-part activity. It is broken down in sequential detail in Figure 4-1, A-1. The first was discussed earlier under "actors and roles." It consists of an optional visit to the building department for an informal, "over-the-counter" discussion between the building owner and/or his agents (architect, engineer, contractor), and a department "counter-engineer." Issues which arise during early or conceptual stages of "design and engineering" are discussed. The second part is filing for plan-check, plan-checking, and subsequent resubmission of corrected documents. The third is filing for an actual building permit on the basis of the now-approved construction documents. The fourth part is department inspection of the site as actual construction progresses. The fifth and final stage is filing for an occupancy permit.

The second and third stages require the payment of fees proportional to the value of the project — often a very substantial amount. They largely financially support operations of the department. (The final phase requires but a nominal fee.) All of the opinions, rulings, and approvals obtained in each phase are voidable in the following phase or phases, with final say being held by the inspector on site — regardless.

"The Experimental Project" (Figure 4-1: A-2) is used by selected jurisdictions. It is similar to, and largely follows the normal, project-specific building-permit/plan-check process. It works best when objectives of both the proposer and the jurisdictional body are served. That is, the proposer may have a new technology, material, subsystem, or construction methodology that is not covered by the code. He requires actual experience with it in the field before possibly seeking more permanent (expensive, and time-consuming) forms of code change. The municipality, for its part, may be interested in similar experience with the innovation; e.g. — it sees numerous future requests of a similar type and/or is feeling pressure to respond to public calls for acceptance or change of a new technology (such as occurred in the realm of industrialized housing in the '60s and is occurring with solar energy systems now). Approval here is on a one-time basis only, maybe for a limited period of time, and may have modest to quite serious conditions attached to even this very limited form of approval.

The "Research Report" (Figure 4-1: A-3) is the means by which most building code jurisdictions operationalize the quasi-performance oriented "alternative" provision typical of most codes. A common statement is:

BUILDING DEPARTMENT "EXPERIMENTAL PROJECT" DESIGNATION

(Used by Selected Jurisdictions Only)

ISSUANCE OF A PERMIT AND MONITORING OF A PARTICULAR BUILDING PROJECT WHICH UTILIZES NEW CONSTRUCTION PROCESSES OR MATERIALS. (THE BUILDING DEPARTMENT MAY DESIRE EXPERIENCE WITH THE NOVEL BUILDING PROJECT, ALTHOUGH IT NEITHER CONFORMS OR IS COVERED BY PRESENT CODES.)

—AN ADMINISTRATIVE PROCESS—

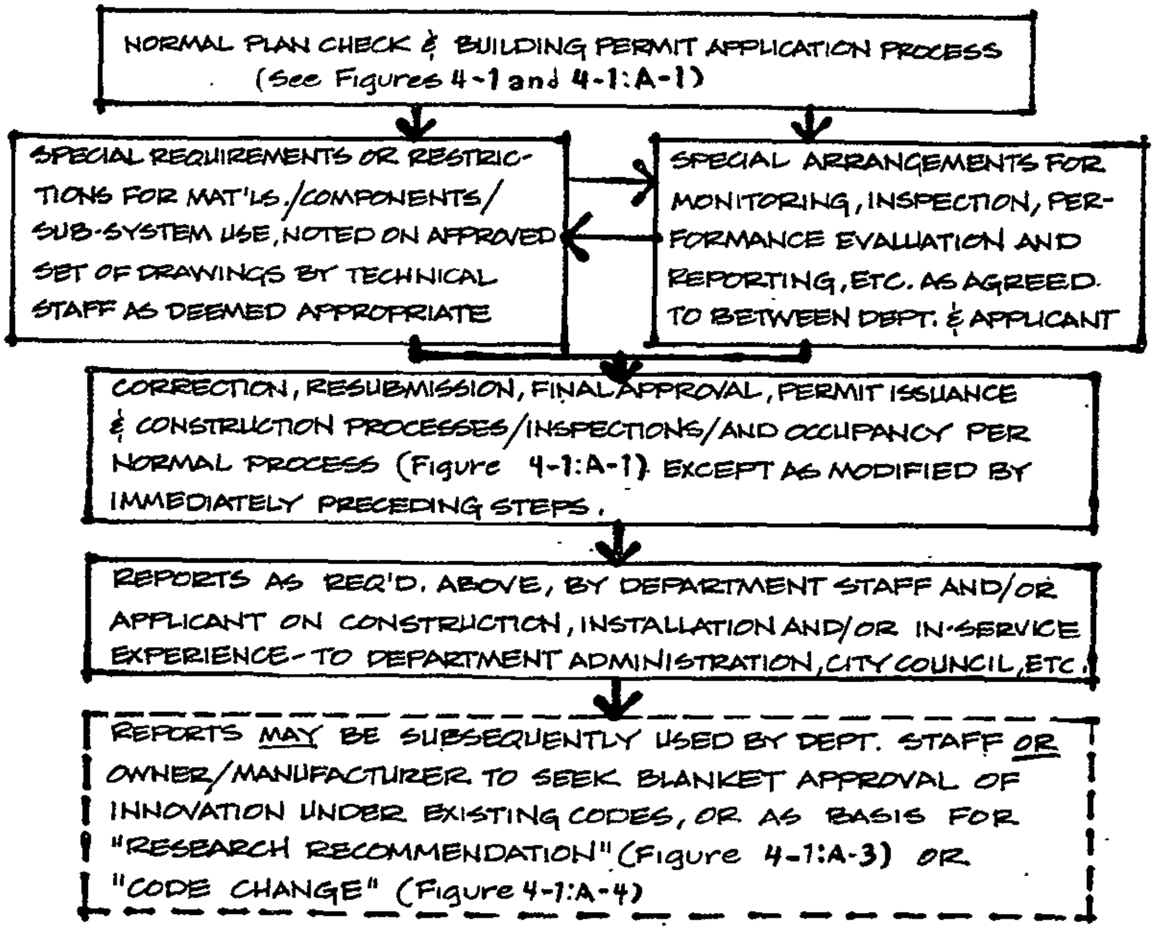


Figure 4-1: A-2. Building Department "Experimental Project" Designation

GENERALLY NON-PROJECT SPECIFIC REPORT ON THE USE OF A NEW COMPONENT, MATERIAL, OR PROCESS NOT CURRENTLY COVERED BY THE CODE, ISSUED TO ALL JURISDICTIONS/MUNICIPALITIES USING THE MODEL CODE, AND OTHER SUBSCRIBERS.

—A TEMPORARY MODIFICATION OR ADDITION TO THE CODE—

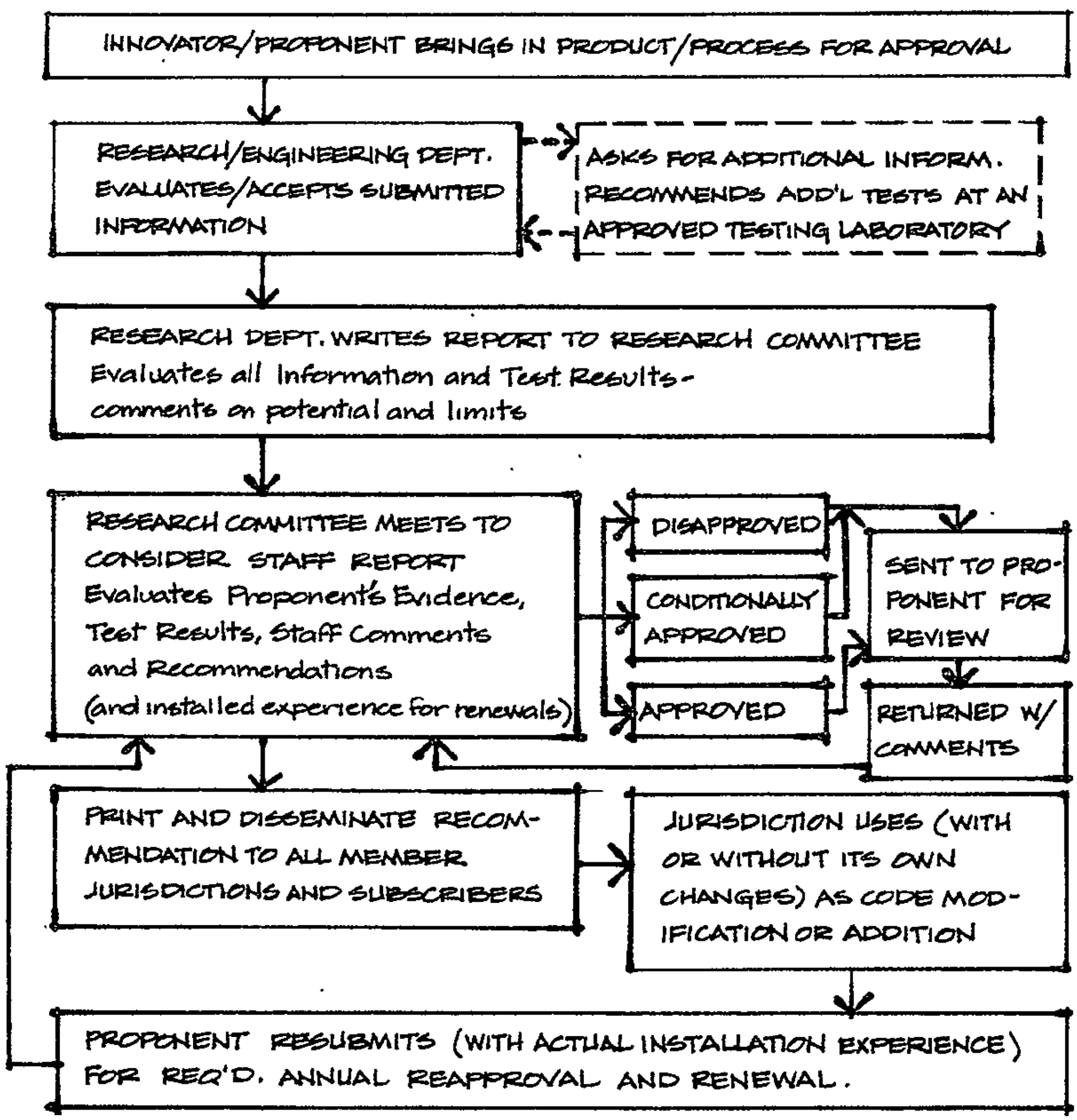


Figure 4-1: A-3. Model Regional Building Authority
Research Report/Recommendation

"the provisions of this code are not intended to prevent the use of any material or method of construction not specifically prescribed by this Code, provided any such alternate has been approved."

Where a model code used by many jurisdictions is involved, the "research report" becomes the closest activity to the European "Agreement" system. As in Agreement, positive recommendations are incorporated as such by 99% of the local authorities, although they have power to refuse or to alter approvals as applied in their jurisdiction. This is even truer now that "research recommendations" are received by and acted upon by the joint Council of American Building Officials. It is made up of three of the four major model code organizations in the country. They are: The International Conference of Building Officials (The UBC), Building Officials and Code Administrators International, Inc. (The BOCA Code), and The Southern Building Code Congress (Southern Building Code). While each participating code group must review and take action separately, thereby increasing approval time and cost commensurately, at least there is a common and standardized format of approved testing procedures and laboratories which need not be repeated. A positive research recommendation from the Council facilitates use of the innovation in localities served by all three codes, although on the same limited-duration basis as a recommendation by any one.

While the preceding changes to code requirements are all of conditional or limited duration, an actual code change (Figure 4-1: A-4) is permanent. However, they are subject to future change as are existing sections of the code. In fact, it should be noted that since codes are generally (but not always) reactive in nature, subsequent failure of an innovative material, system, or construction technique will generally bring about prescriptive changes and restrictions on further use. For example, should antifreeze (glycol-filled) collectors leak onto and destroy built-up roofing or perhaps cause human injury, strong code reaction to prevent future occurrences of either situation can be expected. Actual changes to the building code involve a modest fee, if any at all, but can actually be extremely time-consuming, very uncertain of success, and therefore the most expensive of all. Finally, code changes can be initiated by code administrators themselves (or their technical staffs) as well as by manufacturers, inventors, and, to a lesser degree, builder developers, architects, engineers, etc.

C. ZONING APPROVAL PROCESSES

As shown in Figure 4-1, the most typical or standard zoning activity in regard to actual building projects is the "zoning in" of such projects — during the building permit process. (Thus, there is no separate Figure 4-1: B-1.)

The "Zoning Variance" (Figure 4-1: B-2) is perhaps the most controversial of all approval processes. Immediate neighbors may object to variances for projections of the proposed structure into otherwise

NON-PROJECT SPECIFIC CHANGE IN CODE'S FORMAT, ADMINISTRATION, WORKING AND/OR TO CONSTRUCTION TECHNIQUES, PROCESSES, DESIGN METHODOLOGIES AS WELL AS TO SPECIFIC MATERIALS, COMPONENTS, OR SUB-SYSTEMS INSTALLED THEREUNDER

— A PERMANENT CHANGE TO THE BUILDING CODE —

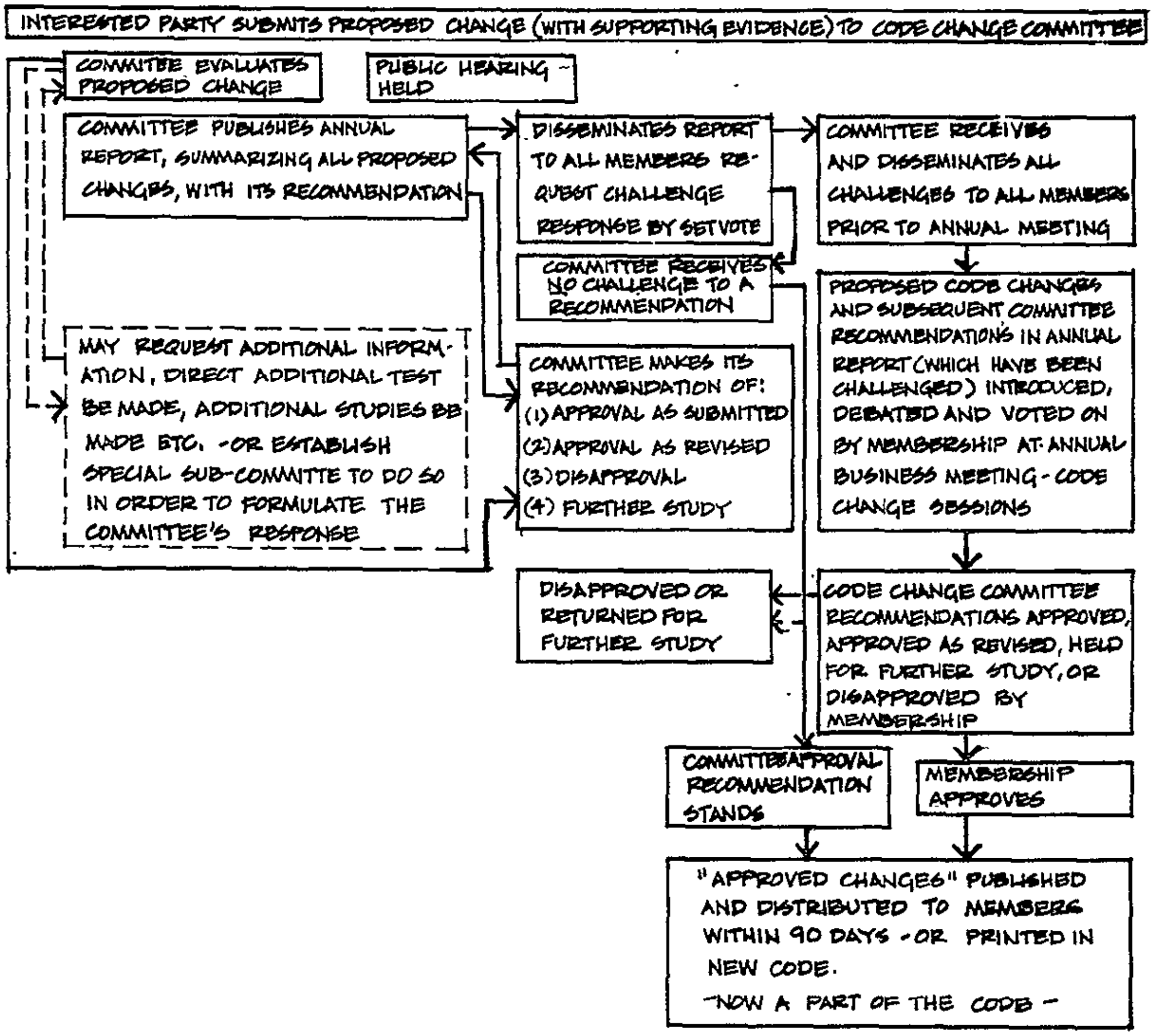


Figure 4-1: A-4. Model Regional Building Code Authority - Changes to the Building Code

PROPOSED USE OF LOT OR PARCEL @ VARIANCE W/ ZONING ESTABLISHED/EXISTING FOR THE SITE

-AN ADMINISTRATIVE PROCESS-

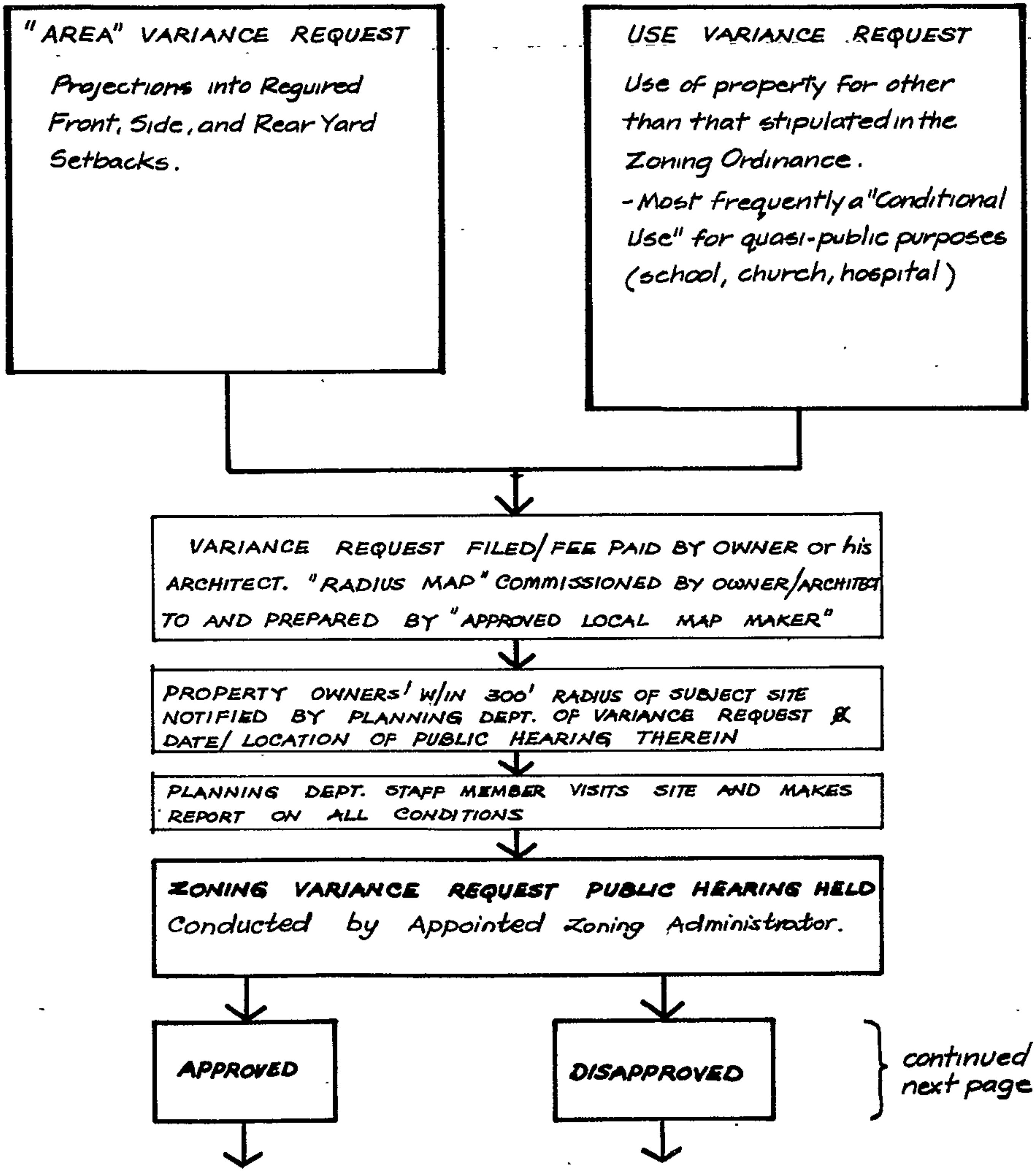


Figure 4-1: B-2. Planning Department - Zoning Variance Process

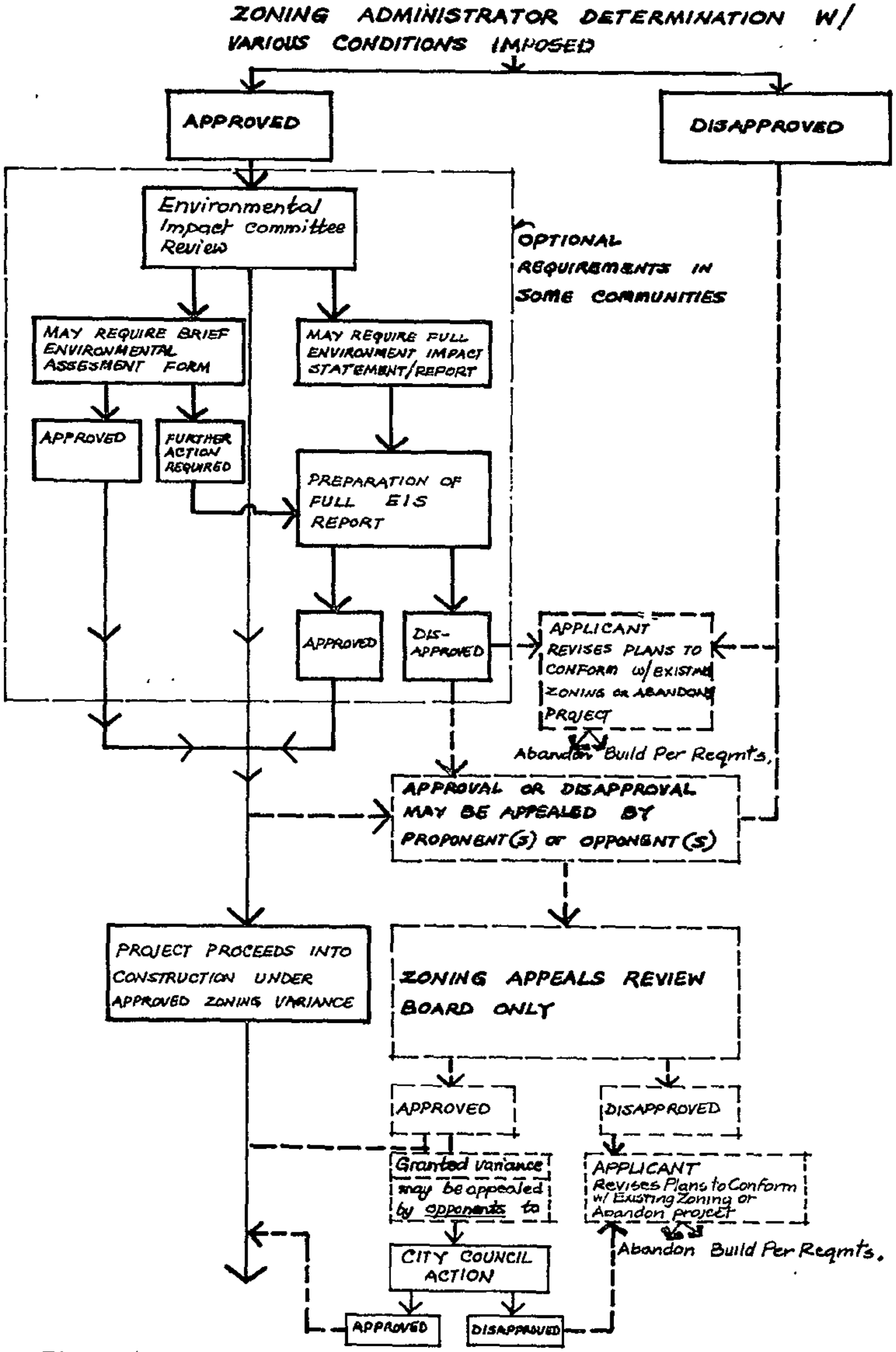


Figure 4-1: B-2. Planning Department - Zoning Variance Process (Continued)

prohibited "yard" areas. Conditional use requests for nonconforming buildings on a site can be fought by an entire neighborhood — and frequently are. The process can be loud, long, painful, and costly to all participants.

Actual "Zone Change" (Figure 4-1: B-3), like building code changes are the most permanent and therefore the most costly in time and money (beyond minimal application costs). They can involve the politics of an entire city — and the future of its key politicians. As compared to zoning variances, they may be more frequently initiated by city councils and/or planning commissions (e.g., as a part of orderly general plan implementation) than by individual property owners. However, a high degree of volatility is shared by both types of zoning changes because both can produce an "unearned increment" for property owners. That is, through the single act of certain types of variances or zone changes (for instance — from a less dense to a more dense or intense use) a given piece of property can jump immediately and enormously in value. That increase in value accrues to the owner without any capital improvement to the property by him. It's simply a reflection of its increased earning capacity. Time and money costs of such change may be significant as has been noted — but not nearly commensurate with the resultant increase in property value if successful — hence the phrase "unearned increment."

CHANGE IN ZONING OF AN INDIVIDUAL PIECE OF PROPERTY OR CONTIGUOUS AREA

—A LEGISLATIVE PROCESS—

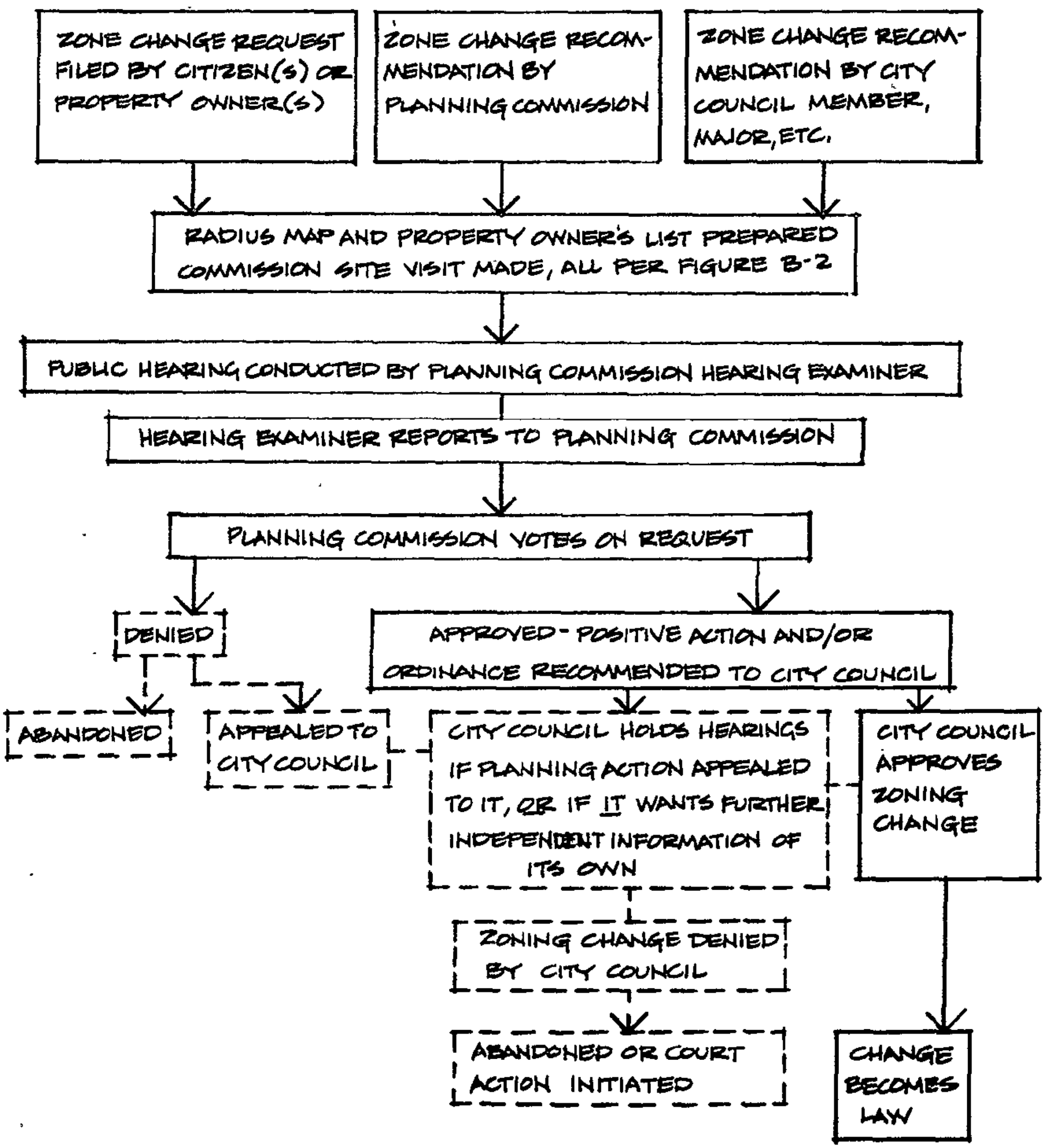


Figure 4-1: B-3. Municipal (or County) Zone Change

SECTION V

INTERIM CONCLUSIONS: FIT OF THE SAGE SYSTEM

A. OVERVIEW

The preceding discussion of building industry characteristics, selected actors and roles, and selected processes, has attempted to establish a context for fitting Solar Assisted Gas Energy domestic hot water heating systems to multifamily housing. Figure 3-1 has been reintroduced in this Section as Figure 5-1 in order to suggest some tentative near- and longer-term conclusions as to how SAGE might be received and how SAGE fit might be achieved.

The actual fitting of SAGE to the U.S. building industry multi-family submarket will be a process of refinement based on the results of all other SAGE technical, marketing, business development, and policy development tasks and upon results gleaned from the two demonstration projects installed under Phase III. Beyond the Project itself (and this report) are the implications of competing fossil fuel rate increases and the cost of so-called renewable energy sources, as well as whatever national energy policy is finally promulgated.

For purposes of the present report, the fit of SAGE can be seen in two different dimensions and levels of specificity. They may in turn involve two different time scales as well, although even now the two can overlap.

B. THE NEAR-TERM FIT OF SAGE

As other "Implementation Task" reports have shown, the SAGE system is most akin to conventional plumbing (or mechanical) systems. Collectors, tanks and heat exchangers are the only truly unique components, with the latter two unique only to this building type but not to the industry or the plumbing trade as a whole. As shown in Figure 5-1, this suggests that Steps 4 through 6 of the industry process flow, or C/D/B, involve design and engineering, costing/bidding, and construction.

Of the 11 key actors whose duration of participation in the overall process were shown in Figure 3-2, 8 or 9 are most heavily involved in those three steps. These include: the builder/developer, lender, general contractor (if different from the developer), subcontractor, architect, consulting engineer, skilled tradesmen, zoning/building code official, and (if identified and part of the project from its initiation, rather than a subsequent buyer) the building owner himself.

If a single observation can be made about this diverse group, it is that they will act as individuals. For example, two competing garden-apartment builder/developers in the same local market may have diametrically opposite views about the near-term marketability

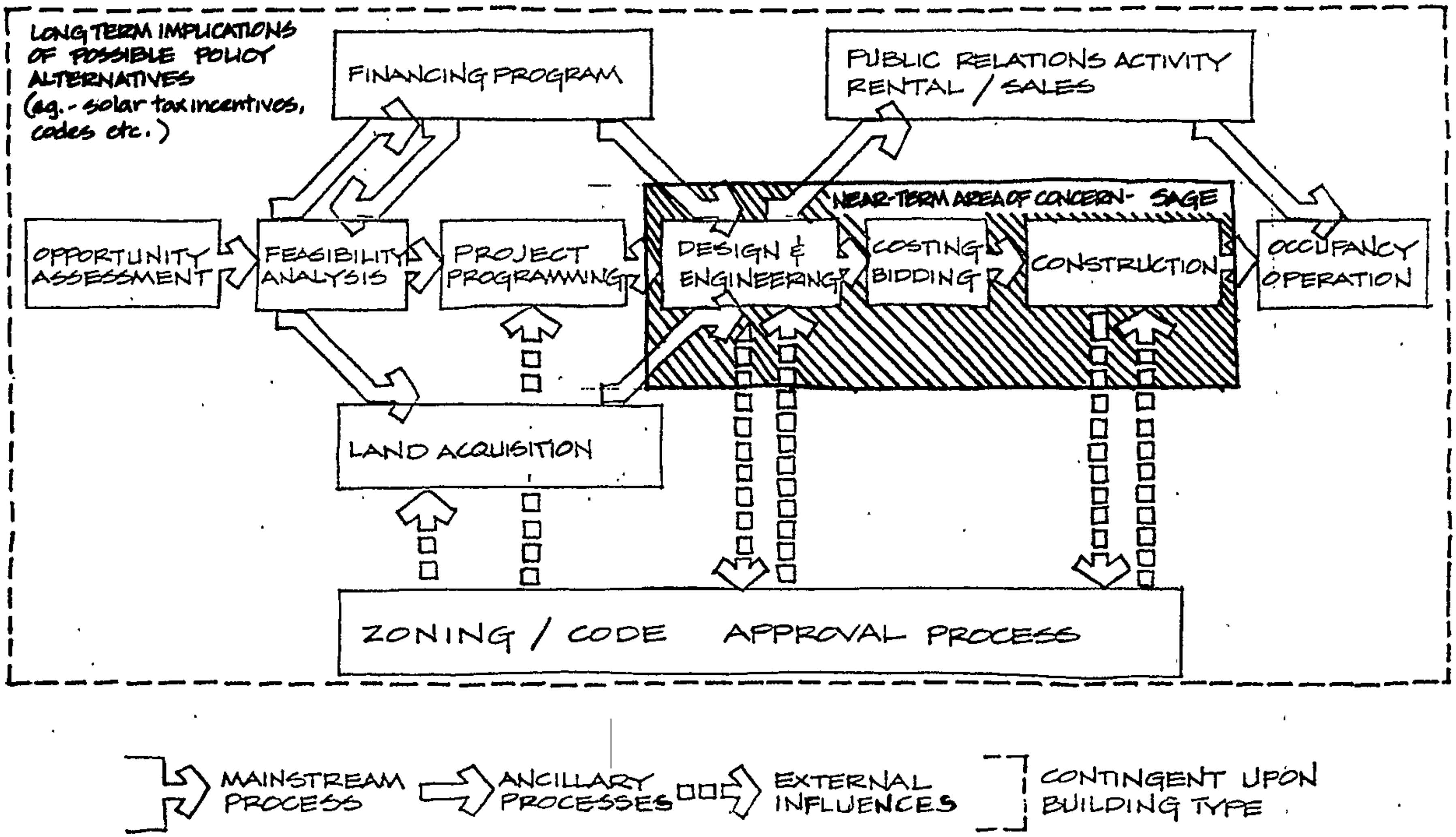


Figure 5-1. Building Industry - Process Flow

of solar-assisted hot water heating systems. The following generalizations, based on all that precedes in this report, are therefore just that -- generalizations which must be carefully adjusted to individual perceptions.

In the near term, the lender may be least interested in a SAGE application. He is conservative by nature and realizes that any incentive he provides to encourage use of the system (e.g. low-interest loans) may serve to increase his risk without increasing his potential return. That is, energy cost savings will accrue not to him but to the project owner or rate-payer. He has thus far been cool to the argument that his population of qualified buyers or renters is expanded by means of lower utility costs allowing more of the housing consumer's housing budget to go for actual housing costs. The builder/developer, general contractor, architect, and engineer may similarly resist applying the system (regardless of cost-competitiveness) in the near term because additional risk and therefore liability may be promised by such application. This can be in the form of uncertain delivery, performance, or required maintenance. However, the subcontractor and skilled tradesperson (especially those in the "wet" or plumbing trades) may be very interested. This is true if they understand the minimal risk-nature of water solar-assisted heating and subsequently see the potential for a very large industry, and considerable new work in their specific trade.

The building owner may have equal trepidation about using a relatively untried technology and its possible ability to adequately serve his building and its tenants. He will be somewhat reassured (during initial solar technology use) if he realizes that full back up is provided and that his tenants may never know what source of energy is really heating their bath water. Like the builder/developer, he may or may not perceive the visible expression of solar technology as attracting — or scaring off potential tenants. In the two demonstration projects, SAGE has usefully shown its capability for being evident and even architecturally expressed, or for being entirely hidden from ground view.

The building manager, if different from the owner, may share similar positive or negative attitudes toward implementing a SAGE-type of system. His emphasis would be on maintenance concerns. If his building is centrally metered, he may be a little closer to rapidly increasing utility costs and commensurately more interested in the energy-savings aspects of SAGE.

As noted earlier, depending on the jurisdiction and upon other pressures faced by the building code official, he or she may want to cautiously try out SAGE via an experimental project, or may simply accept it as another plumbing system. This would be particularly true if its innovative aspects have received some form of conditional or long-term model code approvals. The zoning official will make sure that SAGE components do not violate height limits or encroach upon restricted sideyards. However, the obvious energy/resource conserving aspects of the SAGE system may assist builder/developers in achieving the temporary or permanent zone changes they seek, if they can see solar energy as a

marketing tool. If it is used only as a ploy to achieve rezoning, recent such efforts have shown that it could backfire with serious short-term difficulties for him and longer negative reactions to the system by the public.

The three "design and build" steps of Figure 5-1 have been expanded into detailed substeps in Figure 5-2. Possible tasks that SAGE might execute in order to serve industry needs in incorporating a SAGE-type system are suggested at each substep of the process. Not all functions would be viable for every possible SAGE business plan. However, if that plan is finally configured, the kinds of industry interactions suggested could insure "industry-fit," if strong feedback and self-corrective mechanisms were built in at each point.

C. IMPLICATIONS FOR LONG-TERM FIT

Figure 5-1 suggests that long-term SAGE implications can perhaps impact the entire process by which multifamily projects are conceived, designed, constructed and operated. This can best be understood if one considers two transitional issues first. These may impact SAGE even now and set a pattern for the future.

The first is architectural design. Even if space heating is not involved, the architectural implications of solar energy may be "hide-able" but they cannot be denied indefinately. If a combination of new energy codes and increasing restrictions on conventional development combine to demand a more energy/resource sensitive approach to multi-family projects, the architectural potential of SAGE may be discovered necessarily. If this kind of serious energy-conserving design approach is to be taken, this may require significant shifts in current actor roles and entry/exit points. For example, to integrate solar components into a viable, visible architectural expression, the decision as to its use may have to come before Step 4, "Design and Engineering." Also, questions of appropriate site selection may be involved. Although the SAGE system is a simple enough, almost packageable means of solar-assisting domestic hot water heating, it would also be hoped that the decision to use SAGE would be part of a larger, performance-based, energy-conserving design and building management scheme. If this were so (and the tendency of nonresidential energy codes to seek a performance basis may encourage a similar approach in multihousing) then a more integrated team approach to decision making will also be called for. This requires that architects come to understand engineers and engineering better and engineers come to understand architecture and architects to a much greater degree. Therefore, both may be called in earlier by the developer.

The second transitional issue is really an off-shoot of the first and may in many ways hasten the changes suggested here. It is the area of policy creation and implementation. By whatever means (deregulation, incentive creation, etc.) the costs of conventional fuels are allowed to "seek" higher levels and/or the installers or users of solar systems are economically rewarded for their actions and those changes will be

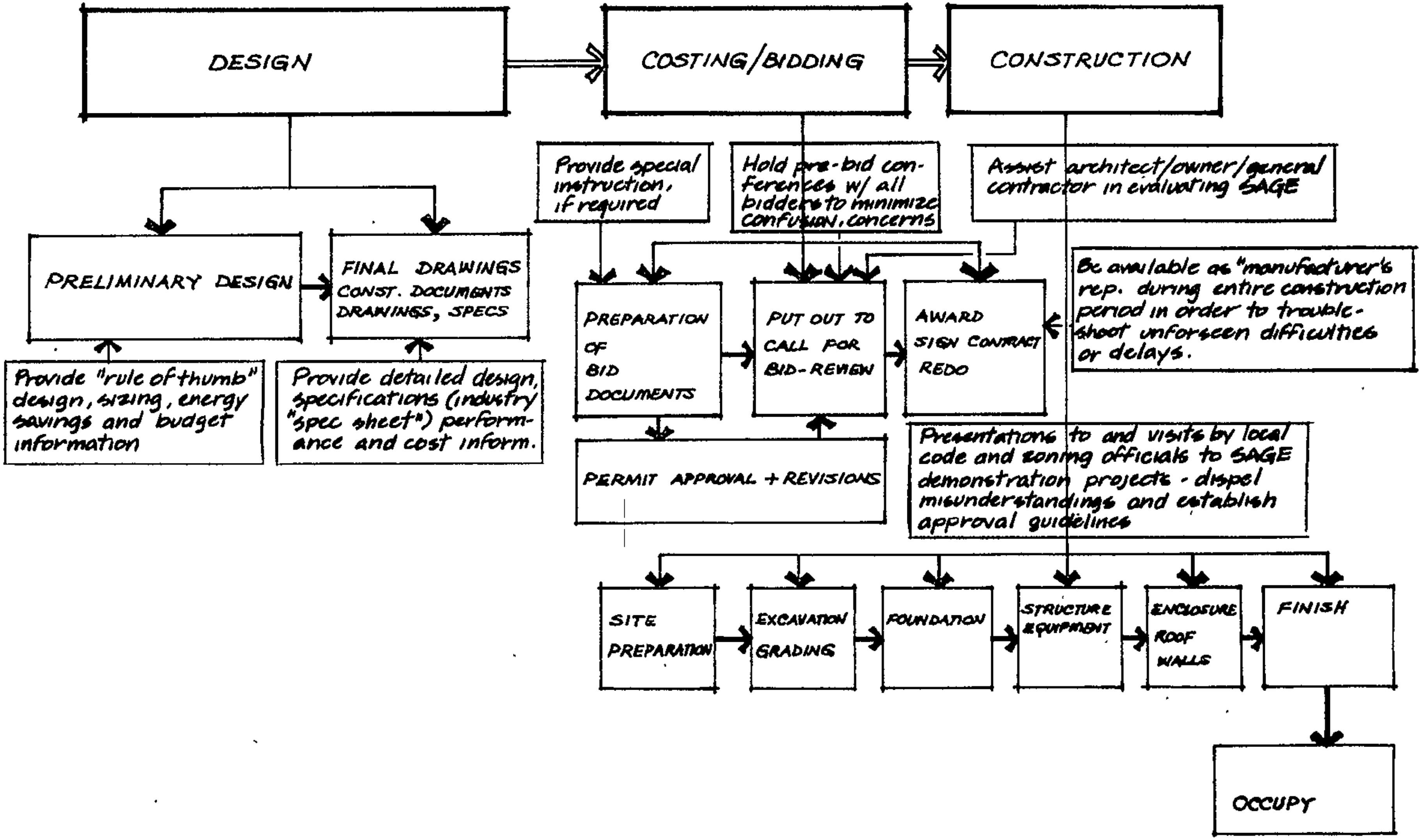


Figure 5-2. Fitting SAGE into the "Design and Build" Portion of the Building Industry Process Flow

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hastened. It is also possible that punative or otherwise restrictive legislation may be enacted which will require the use of solar energy on all buildings. If this latter type of legislation or administrative fiat occurs, we will be dealing with but another prescriptive specification code. As with other such codes, the result is often to encourage minimum compliance within the letter of the law rather than a creative response to its intent.

The intent of SAGE, if commercialized, is to provide a means by which approximately 3 to 4 Btus of sun energy are used for every 1 Btu of natural ges energy for the heating of hot water in apartments at a reasonable profit, thus stretching available supplies thereby. In concert with other energy and resource conservation objectives, the result may just be a significant restructuring of building industry characteristics and the emergence of an environmentally responsive architecture.

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